Journal of Dental Science-UDMY

Vol.1, No.1

January, 2020

ISBN - 978-99971-0-828-9

ISSN : 2707-6504

University of Dental Medicine, Yangon

www.udmyangon.-edu.com

FOREWORD

Dear esteemed colleagues,

It is a great honor for us to have an opportunity to publish the very first and foremost journal. Thousands of miles are usually started with first step for very long journey. We hope this is just beginning which will remain as historical milestone and it also makes a history. As UDM-Yangon is a unique place where opportunities await for students, we have a great passion to create opportunity for them and we would like to also share the knowledge to all dental professionals which way we are heading and what we are doing. Myanmar has tremendously changed since 2015 November and although it is striving like a candle in the wind, we can see some smooth transition especially in dental health sector in compared with last one to two decades. Fortunately, Ministry of Health and Sports allowed more and more implementation grants for doing basic, clinical and public health researches so that our Faculty staff can conduct advanced clinical researches in collaboration with Department of Medical Research. Hopefully, this journal can provide some comprehensive dental education concepts and research works based on digital dentistry to our professional colleagues. My heartfelt thanks and sincere warmest appreciation are extended to all who put their sustainable effort and who were also the parts of brick and grains of the sand to develop this journal without which our dream could not be materialized.

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JDS
Editorial
Towards Gorgeous Future by Digital Dentistry

Evolution towards digital dentistry is a dynamic process, which updates the dental profession in this modern world. The digital technology in today dentistry is beneficial for an efficient processes, as well as accurate high-strength materials for overall patients' needs by replacing outdated management. A variety of digital devices such as intraoral and face scanners, cone beam computed tomography (CBCT), software for computer-assisted design/computer-assisted manufacturing (CAD/CAM), and 3D printing give best evidence for the new and superior technologies to replace the manual tasks.

Digital dentistry has several benefits, including accurate measurements, data storage, information sharing and time-saving. In addition, online consultation and presentation collectively known as teledentistry, provides information exchange with local and international institutions for planning and appraising management according to the feedback or opinion from a specialist. Teaching institution and research centers are greatly benefited from digital innovations, with software for teaching dentistry (such as 3D software for learning anatomy or 3D simulation programs for surgical procedures), digital archiving of patient records and instance sharing of digital files over the internet, digital bibliographic assistance in dental research, or other utilities.

An intraoral scanning (IOS) is a chair-side probe/wand, which introduced into a patient's oral cavity and taking copious amounts of pictures and compiling those pictures together to create three dimensional images. When the scanner is used to collect the data from conventional cast model and that hybrid technique is known as an extraoral scanning (EOS). Advantages of IOS are faster and efficient to create the details of patients' oral cavity, help to reduce the errors caused by discomfort. And less in chair side time makes the patients happier and it gains the trust of patients to the dentist thus obtaining better patient dentist relationship. Now in Myanmar, both IOS and EOS are popular among dental practitioners.

Besides, scanners are not restricted to intraoral probes; they could be used with cone beam computed tomography (CBCT), which can produce undistorted three-dimensional information of the maxillofacial skeleton with a lower radiation dose. For instance, CBCT and IOS with implant planning software possible to makes the surgical procedures in replacement of missing teeth. More than that, use of CBCT is able to prove accurate documentation of oral characteristics, such as odontogenic cysts and tumors.

CAD/CAM in dental technology is currently used as a synonym for prostheses produced by 'milling technology'. All CAD/CAM systems consist of three components: a digitalization tool/scanner that transforms geometry into digital data that can be processed by the computer, software that processes data;

depending on the application, produces a data set for the product to be fabricated and the last, production technology that transforms the data set into the desired product. Moreover, CAD and 3D printing technology are also useful for fabrication of orthodontic appliances and clear aligners.

In coming years, there will be a further improvement with newly introduced materials and devices. Especially, the digital era has begun to change the world of dentistry, changing patients' expectations towards dental treatments. Therefore, dental professionals need to change the way of thinking, communicate, and work to adapt to a new challenging scenario for patient care, dental research and education.

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Simulated Toothbrushing Wear of Different Composite Resin Restorative Materials

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Abstract **- This study evaluated surface roughness after simulated toothbrushing of five commercial composite resin restorative materials: one microhybrid: Denfil; one Ormocer: Admira; two nanohybrids: Grandio and Ceram X mono; and one Giomer: Beautifil II. Cylindrical specimens of five composite resin (n=12 for each material) were used. All samples were brushed for 200 min with dentifrice-water slurry in a simulated tooth-brushing machine. This period is clinically equal to two years age of toothbrushing. Before and after simulated toothbrushing wear para-meters for surface roughness (Ra, µm) were determined by a surface profilometer respectively. The data was statistically analyzed by one way analysis of variance (ANOVA) and Tukey's post hoc test to evaluate the difference among the tested materials and Paired Sample T test to evaluate the surface roughness changes after simulated toothbrushing. And then, comparing the surface roughness among the tested materials: Denfil, Admira, Grandio, Ceram X mono and Beautiful II. SEM observation was done to evaluate the changes in surface topography of all tested composite resin materials before and after simulated toothbrushing. The mean percentages for surface roughness, initial surface roughness means ranged from 0.2081 (0.0672), 0.1571 (0.0294), 0.1977 (0.0642), 0.1977 (0.0679), and 0.1822 (0.0641) for Denfil, Admira, Grandio, CeramX mono, and Beautifil II respectively to 0.3072 (0.0957), 0.2331 (0.0489), 0.2315 (0.0705), 0.2252 (0.0880), and 0.1995 (0.0605) after testing. After simulated toothbrushing, statistically significant change in weight loss and surface roughness was detected in all tested materials (p<0.01). The results of this study suggested that some important general relationships exist between the compositions, micro-structures and mechanical properties of tested composite resins. The analysis of differences before and after the simulated toothbrushing may provide some further basis for a rational choice of the most appropriate composite resin material from wearing aspect.**

Keywords; toothbrushing, surface roughness, composite resin

Received: October 2019
Accepted: December 2019

Introduction

Research in the aesthetic dentistry seeks to meet to the demands of the clinicians, who desire restorative materials with easier handling characteristics and superior physical, mechanical and aesthetic properties. However, it is known that achieving all these characteristics in one material constitutes a difficult task (Chimello *et al*., 2001). In that, the most important property is the ability to withstand wear, as any loss of substance could result in altering the anatomic shape

and affecting the performance of restoration. Nowadays, composite resins are so far the most esthetic restorative material applied in direct restorations. These materials offer the patients with minimally invasive, highly aesthetic in performance. However, the aesthetic property of these materials is unpredictable due to their discolouration or loss of luster, owing to surface wear.

Despite improvements in mechanical properties and wear resistance in composite materials, wear is still a cause of clinical failure, particularly in high stress areas such as molar restoration (cited in Sarett, 2000). Decreasing wear resistance created the surface roughness of restorations and complicated as plaque accumulation, loss of surface gloss and further attack of caries development. Therefore, adequate wear resistance is the most important requirement for posterior restoration. However, numerous studies have been carried out to investigate wear of composite resin restorations and most of them showed that wear is inevitable. During maintaining oral health and restorations, dental tissues and dental materials are subjected to tooth brush/ toothpaste abrasion, but an impact of toothbrushing on appearance of composite resins may occur (cited in Strassler, 2010). This may cause wear on dental tissues and dental materials during removal of surface deposits especially in the cervical third area of facial surfaces of the teeth. This effect leads to changes in the surface condition of any composite material.

As many researchers reported conflicting papers on the ability to predict wear from the physical and mechanical properties of composite resins, actual testing and measurement are required. However, clinical tests (*in vivo*) are not easily performed, as there are problems associated with the type of trial tests. Simulation testing should achieve in the shortest possible time for the test to be a useful alternative to a protracted clinical trial (Mandikos *et al*., 2001). Up to now, a more reliable way of studying wear resistance in vitro is to use a toothbrush machine with dentifrices and prophylaxis materials. It simply simulates the wear mechanism that occurs during toothbrushing. The surface roughness produced by a tooth brushing abrasion test reflects the abrasive resistance of the resin materials.

The type of composite material is especially important from a clinical standpoint, because the type and composition of the current composites introduced as restorative materials differ widely. Thus, many researchers reported that evaluation of the mechanical properties of restorative materials is necessary to ascertain their indications and limitations. As a matter of fact, wear of tooth coloured restorative materials is still concerning. Controversial results were determined associated with various degree of wear resistance of restorative materials to different degree of abrasivity and various testing methods. Hence, it is necessary, to understand the wear resistance of different composite materials. In this study, it was taken into consideration to evaluate the surface roughness of different composite resin restorative materials with respect to the esthetics and function of restorations which are important for longevity of restorations.

Materials and Methods

The wear of five commercial composite resin restorative materials were compared after simulated toothbrushing: one microhybrid: Denfil; one Ormocer: Admira; two nanohybrids: Grandio and Ceram X mono; and one Giomer: Beautifil

II. List of these materials used, manufacturers, composition, and batch number are shown in Table 1.

Table 1. Details of tested resin materials

Trade name	Manufacturer	Lot number	Main composition	Average Filler particle size	Filler content wt% / vol%
DenFil	Vericom, Korea	DF 2417922	Microhybrid Bis GMA, TEGDMA	≤1.0 µm	80% wt
Admira	VOCO,G mbH Germany	1002512	Ormocer based microfilled 3-dimensionally linked inorganic – organic copolymer (ORMOCERS) Additive aliphatic aromatic dimethacrylate	0.7 µm	56% vol
Grandio	VOCO,G mbH, Germany	1047274	Nanohybrid Matrix: Bis-GMA, UDMA,TEGDMA, dimethacrylate	0.1 – 2.5 μm^{β} 20 -50 nm^{θ}	71.4 % vol 87% wt
Ceram® X mono	Dentsply Asia	13030000 81	Nano-ceramic Methacrylate mod-ified polysiloxane dimethacrylate resin	1.1– 1.5 µm	57% vol 76% wt
Beautifil II	SHOFU, Japan	031135	S-PRG filler	10-20 nm	83.3 %wt

Twelve cylindrical specimens were made of each material using a stainless steel mould (2 mm thick and 9 mm inner diameter). Each material was inserted directly into a mould with a plastic instrument. A microscope glass slide (Mariefeld, Germany) interposed with a cellulose matrix strip (PN 1148, SHOFU, Japan) was placed on the composite resin to avoid air inhibition layer (oxidizing layer) and to obtain a smooth surface with the polish of natural resin. Finger pressure was used for 30 seconds, to remove the excess and obtain a flat surface. After this time, the pressure was removed. The specimen was polymerized in accordance with the manufacturer's recommendations, i.e. 40 seconds, covering the total area with a high intensity visible light (LED) source (Guilin Woodpecker medical instrument Co. Ltd, Guangxi, China) with an output of 800 mW/cm2 at all times keeping the tip as close as possible to the resin surface and perpendicular to the restoration surface (by touching to the surface of glass slab at all times). The output from the curing light was periodically monitored with a curing radiometer (DigiRate radiometer, LM-100, Monitex, Taiwan). Polymerizing the composite materials against a glass surface is a method commonly used by researchers to produce a standardized surface finish for testing (Tanoue *et al*., 2000). The chosen technique excluded air from the composite surface and thereby minimized oxygen absorption to produce an oxygen-inhibition layer. The degree of attenuation of the high–intensity curing light due to the borosilicate microscope slide (1 mm thick) was judged to be negligible. To reduce variability, the same shade of composite materials (shade–A3) was used and operated by the same operator. The specimens were examined for obvious voids, bubbles, and surface imperfections with handy magnifying glass (magnification × 3). The specimens were labeled on the bottom.

The samples were stored in distilled water at 37 degree centigrade for 24 hours to allow completion of polymerization reaction. Moreover, they would get hygroscopic expansion and would not absorb dentifrice slurry during tooth-brushing test.

Thereafter, the specimens were polished with wet 800- grit, followed by 1000-, 1200- , 1500- and 2000 grit silicon carbide waterproof electro coated abrasive papers in a polishing machine under running water to obtain a plane, smooth and glossy surface. Each grit was ground for 10 sec. The rationale for the use of

2000 grit silicon carbide paper is to produce an optimally polished surface and to have a comparable initial roughness which allowed us to better assess the materials' roughness as well as to remove the oxidizing layer. After finishing and polishing, specimens were rinsed with running tap water. Then ultrasonic cleaning of the polished specimens was performed for 3 minutes in water to remove any surface debris. Afterwards, each specimen was dried with absorbent paper to remove excess water. And then each specimen was dried with gentle air. To ensure the dryness, the specimen was placed in air for 24 hours. All the procedures were performed under ambient light and temperature.

The alteration in surface topography of specimens was initially measured with surface roughness tester (SRT-6200, Lanetech Co. Ltd, Beijing, China) to verify the roughness (Ra) values of the surfaces before tooth brushing. To measure the roughness profile value, the diamond stylus was moved across the surface under a constant load. The instrument was calibrated using a standard reference specimen. Five readings were made on each surface using a stylus tip (2 µm in diameter).

The surface was profiled at five different locations for each specimen. These measurements were one in centre area and four different directions through the centre of the. For every reading made, the mean roughness value (Ra, µm) was represented by the arithmetic mean between the peaks and valleys registered. After the stylus of the profilometer had scanned, a stretch of 2.85 mm in length, with a cut-off of 0.25 µm to maximize the filtering and undulation on the surface. Initial roughness data was expressed as R1. In order to study the appearance of the polished and finished surface of the specimen as a baseline, a scanning electron microscope was used. Scanning electron microscopy (SEM) has been largely used in dentistry to study surface characteristics of different materials. Only two samples for each group which Ra values tested by surface roughness tester are closest to mean value were selected.

The surface of the specimens was sputter-coated with platinum and then observed using a scanning electron microscope (JEOL JSM – 5610 LV, Japan) with a magnification of 550× and 5500×. To evaluate the same specimen after toothbrushing, the palladium sputter was removed with alcohol before submitting the specimen to the toothbrushing device.

The samples were identified and subjected to the mechanical tooth brushing test. Each specimen was fixed on a specimen holder attached to a toothbrush abrasion testing machine. In tooth brushing simulating machine, Oral B electric tooth brush (Oral B: Advance Power 400, powered by BRAUN, Germany) was fixed to the apparatus and kept alongside the samples, using slurry of Colgate® Total 12 Clean Mint dentifrice with deionized water in a ratio of 1:2 by weight, according to the ISO specification (cited in Mondelli, 2005).The dentifrice was placed between the brush and the surface of the material to maintain constant supply of abrasive during brushing. The water level of the slurry was kept high enough to ensure that the brushing surface was under the dissolved dentifrice. The dentifrice slurry was regularly changed after 100 minutes of brushing time which is clinically equal to one year age. The slurry pH was checked during the test (between 7.0 and 7.4). Simulated toothbrushing was performed with rotation and oscillation action (oscillating at 7,200/min). Bristles are

flexisoft and colour fade was indicated to replace brushhead. In the present study, each brushhead was used for only one specimen. The test was made under a load of 350 grams, to simulate the force of tooth brushing procedures. Each specimen was brushed for 200 minutes (3 hours and 20 minutes). According to Heintze's work (2010), this period is clinically equal to two years age of toothbrushing. Following the test, the specimens were removed. Specimens were rinsed with running tap water to remove surface debris and ultrasonically cleaned with water for 3 minutes. And then each specimen was dried with gentle air. To ensure the dryness, the specimen was placed in air for 24 hours. Final roughness measurements were made according to initial measurement protocols. The measured final roughness data was expressed as R2.

The roughness alteration (changes in surface topography) was observed by the difference between baseline and final reading means. In order to study the changes in surface topography of different composite resins after toothbrushing, a scanning electron microscope was used. For each group, Ra values which were nearest to the mean values were selected. The wear resistance was evaluated through the averages of surface roughness. This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon.

Statistical Analysis

The data was statistically analyzed by one way analysis of variance (ANOVA) and Tukey's post hoc test to evaluate the difference among the tested materials. Paired Sample T test was used to evaluate the surface roughness changes after simulated toothbrushing. The results were analyzed by calculating the mean and standard deviations for each experimental group.

Results

The results of average surface roughness before and after simulated toothbrushing can be observed in Figure 1.

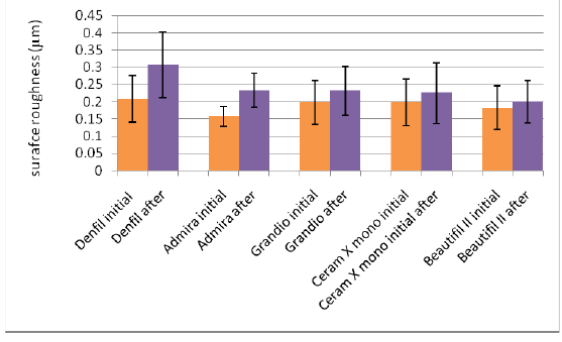

Figure 1. Bar chart showing surface roughness of different composite resins before and after simulated toothbrushing (Mean±SD) (Error bar denote standard deviation)

It shows graphically comparison of average surface roughness alteration of different composite groups after simulated toothbrushing. All tested composite materials demonstrated more surface roughness values after simulated toothbrushing wear. Denfil and Admira groups showed greater surface roughness alteration than Grandio, Ceram X mono, and Beautiful II specimens (p<0.01).There were no statistical differences between Grandio, Ceram X mono, and Beautiful II (p>0.05). However, Beautifil II presented the least surface roughness alteration result, and Denfil showed the largest degree of surface roughness alteration without statistical differences with Admira.

Scanning Electron Microscope (SEM) Observation

The surface topography of all tested

composite resin materials before and after simulated toothbrushing wear were compared in Figure – 2.A, B, C, D, E. The SEM microphotographs in Figure 3 illustrate the surface texture of tested resin composites based on surfaces pre-ground with 800, 1000, 1200, 1500, and 2000 – grit SiC paper respectively (done as finishing procedure before simulated toothbrushing) and surface wear after simulated toothbrushing.

Generally, all composite groups tested in this study exhibited rougher surface texture after toothbrushing. When observing the images of SEM before toothbrushing, Denfil and Admira groups revealed the grinding scratches on the surface owing to finishing procedures. Moreover, some area of surface of Admira presented grooves and facets. Remaining three groups showed no scratches and mostly smoother surfaces than previous two resins. However, exposure of inorganic filler particles which distributed homogenously in different shapes and sizes was detected. Among the tested materials, fillers of Ceram X mono was the smallest in size and homogenously distributed, although Grandio and Beautifil II distributed irregular and larger filler particles and among them nano sized particles were filled. In addition, some areas of SEM images showed voids appearance. When observing the images of tested materials after simulated toothbrushing, a combination of filler exposure, loss of inorganic particles and resin matrix wear were detected. When analyzing the size of holes and craters, there was no broader than filler particle sizes. Hence, it may be due to exfoliation of filler particles. However, in case of Denfil and Beautifil II, there may be occurred a few larger holes, it may be due to dislodging of filler particle and resin matrix couple clusters.

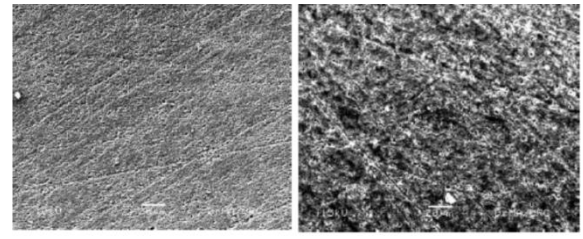

Figure 2A. SEM microphotographs of Denfil composite before and after simulated toothbrushing wear (550×)

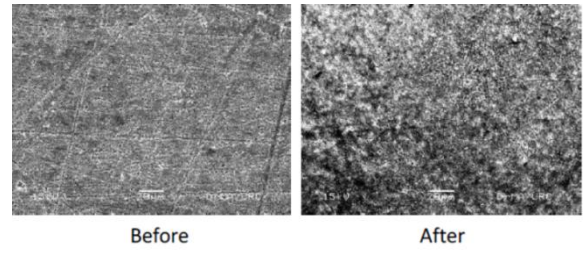

Figure 2B. SEM microphotographs of Admira composite before and after simulated toothbrushing wear (550×)

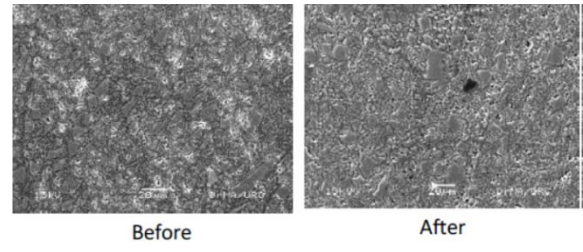

Figure 2C. SEM microphotographs of Grandio composite before and after simulated toothbrushing wear (550×)

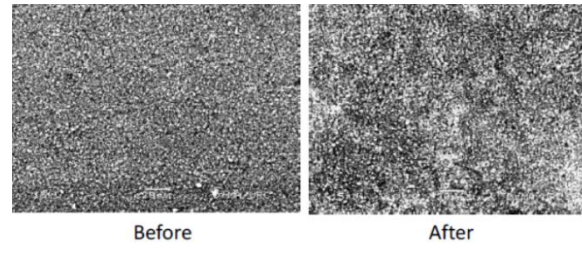

Figure 2D. SEM microphotographs of Ceram X mono composite before and after simulated toothbrushing wear (550×)

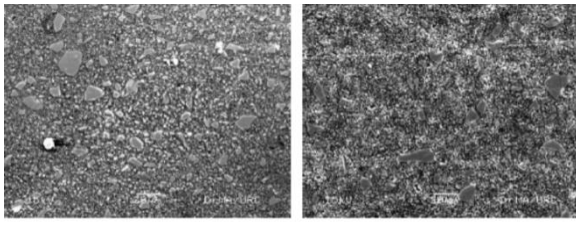

Figure 2E. SEM microphotographs of Beautifil II composite before and after simulated toothbrushing wear (550×)

Discussion

The ultimate goal of continuous material research and development is to enhance the practice of dentistry. The present study assessed surface roughness of different composite resin restorative materials after simulated toothbrushing.

The simulated toothbrushing abrasion with dentifrice slurry caused significant surface roughening for all tested resin materials. Moraes *et al.*, (2007) reported that the roughening effect could be rather significant, and the materials with finer particles showed lower roughening. Similar findings of the present study agreed with their results except for Beautifil II (Giomer) material.

Concerning with Beautifil II composite (Giomer), while analyzing with profilometer, its surface roughness was the least among the tested groups, although there were no statistically differences between Grandio, Ceram X mono and Beautifil II ($p>0.05$).

Composite resins have a mixed structure consisting of soft matrix resin and hard filler particles. Unfortunately, there usually is a problem during the toothbrushing. Since the resin matrix and inorganic filler differ in hardness, surface of the composite resins are not abraded uniformly. After toothbrushing, soft matrix resin was firstly worn and the dislodgment of filler particles was caused by long-term use (Tanoue *et al.*, 2000).

The SEM finding of the present study supports this phenomenon. Simulated toothbrushing created scratches on the surfaces of denfil composite (Figure 2A) and plucked the particles away, while a uniform smooth surface could be generally obtained in remaining groups. However, the roughness values were not the same for these groups.

While studying the SEM micro-photographs of tested composites after simulated toothbrushing, a seemingly rather smooth surface was achieved for Admira (Figure 2B) at 550× magnification, but examination at 5500× magnification revealed a less homogenously abraded surface and the exfoliated small filler particles and created the crater like area. Therefore, after the simulated toothbrushing with dentifrice slurry, the surface texture of all tested resin materials were apparently abraded under scanning electron microscopic examination. With the present outcomes, this study agreed with the results of Strassler *et al*., (1988) in which reported that toothpastes can affect composite smoothness. Furthermore, Ergucu and Turkun (2007) observed that profilometric measurements were strongly confirmed by SEM analysis.

While observing the SEM micrographs of the tested materials after the simulated toothbrushing, nanohybrid resins, (Grandio-Figure 2C and Ceram X mono-Figure 2D) revealed lesser values of surface roughness than that of microhybrid resin (Denfil). It was agreed with the work of Oliveira *et al.*, (2012) where they reported that the qualitative analysis of the SEM micrographs of the resins, after the abrasion test, showed more polished surface of the nanofilled and the nanohybrid resins than the microhybrid resins. In addition, they proved that Admira (Ormocer based composite) was

significantly rougher than the nanofilled composites.

In this aspect, the most likely cause of the improved abrasion resistance of the nanohybrids in comparison with microhybrid counterpart lies in differences between filler technologies of these materials. Filler particles should be situated as close together as possible in order to protect the resin matrix from abrasion. The application of nanotechnology to composite research is of great benefit. Due to reduced dimension of the particles and wider distribution, an increased filler load can be achieved, which results in reducing polymerization shrinkage and increasing mechanical properties (Terry, 2004).

Manhart *et al.*, (2000) and Tanoue *et al.*, (2000) mentioned that wear resistance of composite resins could be influenced not only by filler content and size but also by other factors such as matrix-filler interaction. In addition, five possible mechanisms for wear in composite resins: wear of the resin matrix, loss of fillers by failure of bonding to the matrix, loss of filler through shearing of exposed particles, loss of filler through cracking and failure of the matrix; and exposure of entrapped air bubbles (cited in Xie, 2000). The apparent contrast, particularly, between Admira and Grandio may be due to compositional differences in resin matrix and the filler, although they were produced by the same manufacturer. Differences in resin matrix composition may cause the variation in degree of conversion resulting in the different degree of wear. In general, resin matrix was composed of various amounts of Bis – GMA, Bis – EMA, UDMA, TEGDMA according to manufactures' formulations. Depending upon the percentage of TEGDMA, there may be changes in degree of conversion and plasticization (Filho *et al.*, 2008).

However, Soderholm *et al.*, (2001) stated that filler type and loading had little apparent effect on the wear observed. In the present study, Denfil group showed the worst value of surface roughness. It may be due to larger filler particle than other tested groups. The possible explanation relies on the fact that Denfil, even classified as a microhybrid composite, the filler size is ≤ 1 μm. These results are in agreement with data reported by Moraes *et al.*, (2007).

It is essential to determine the initial roughness to establish a parameter of comparison. Admira presented the smoothest surface. It may be due to the fact that it is an Ormocer based composite resin which is able to resist traditional finishing and polishing procedures. In addition, results of initial surface roughness of Grandio and Ceram X mono had no significant difference. This was somehow expected as both them are categorized as nanohybrids.

According to the present study, the surface roughness outcomes revealed variability of performance after simulated toothbrushing. In this study, Admira showed higher surface roughness values while Grandio had lower surface roughness after the simulated tooth brushing. Both composites were produced by the same manufacturer and composed of the same average particle size, 0.7 μm inorganic filler. However, the difference lies in fillers volume percentage (56 vol% and 71.4 vol% respectively). This causes the variation in inter-particle distance. If the distance is farther, resinous matrix can be abraded more leading to increase in the surface roughness. The largest roughness is responsible for an undesirable loss of esthetics of the restoration, due to the loss of surface gloss and biological disadvantages, causing dental plaque accumulation

and increasing the risks of occurrence of caries and periodontal inflammation (Bollen, 1997).

In the present study, nano groups showed less surface wear changes than other groups except Giomer (Beautifil II). By understanding how particle size, distribution, and volume affect the mechanical properties of composite resins, the clinician can accurately diagnose and treat a patient's condition by selecting the appropriate composite resin restorative material. The assessment of the materials in the present study presented different outcomes for surface roughness changes, and it is clear that the mechanisms accounting for these phenomena are more complex than can be explained by filler component alone. Other factors should be also considered. Nevertheless, the conditions established here did not take into account the effects such as variations in pH, composition and temperature of saliva, food and beverages that can fluctuate in the oral cavity, the presence of plasticizing agents and mechanical fatigue such as sliding, abrasion, and the interaction of other stresses that could be encountered in the clinical situation.

It must be acknowledged that this study has several limitations. First, the *in vitro* nature of the present experimentation may limit, at least in part, its applicability to clinical practice. For example, present *in vitro* study correlates only to clinical situations in which there are accessible and relatively flat surface. Hence, the selection of the most appropriate material under these circumstances was recommended, the results obtained both from *in vivo* and *in vitro* should be evaluated together.

Conclusion

The findings in the present study showed that Ceram X mono and Beautifil II maintained comparatively smoother surface than that of other tested materials. But Beautifil II could not resist the wearing process. Therefore, Ceram X mono, one of nanohybrid, is the most reliable aesthetic restorative material that can resist toothbrushing wear comparatively within the limitation of present study.

The results of this study suggested that some important general relationships exist between the compositions, microstructures and mechanical properties of tested composite resins. Although intensive studies have been carried out throughout the decades to produce the most appropriate composite resin restorative materials, there are still considerable differences between the mechanical properties and wear resistance of tooth tissue and composite resins.

The analysis of differences in surface roughness before and after the simulated toothbrushing may provide some further basis for a rational choice of the most appropriate composite resin material.

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The authors declare there is no potential conflict of interest.

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Correlation between Tooth Mobility Measured by Periotest and Radiographic Alveolar Bone Loss in Chronic Periodontitis

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***Abstract* - The aim of this study was to determine the correlation between tooth mobility and radiographic alveolar bone loss in Ramfjord teeth of chronic periodontitis patients. The results of Ramfjord teeth procedure supported conserving time, limiting cost, and reducing patient and examiner fatigue while providing maximal clinical information. Clinical attachment level, periodontal disease index, tooth mobility and radiographic alveolar bone loss were measured in Ramfjord teeth and/ or substitutable teeth with chronic periodontitis of both genders of subjects (age of 35-59 years). A total of 65 subjects (34 males and 31 females) were selected and descriptive cross-sectional study design was used. Correlation between Periotest Value score (PTV) and alveolar bone loss was higher in central incisors (in mandibular central incisors, r=0.526 and $p<0.001$) and (in maxillary central incisors, r=0.455 and $p<0.001$) than premolars and molars. It was the highest correlation in mandibular central incisors. This explained the fact that the alveolar bone and connective tissue attachment play an important role in maintaining tooth equilibrium. It can also be useful in predicting the amount of bone loss for the determination of diagnosis, prognosis and treatment outcomes of the periodontal diseases by using Periotest instead of taking radiographs that is limited in some patients and used as an adjunct in diagnosing periodontal diseases.**

Keywords; tooth mobility, Periotest, alveolar bone loss, Ramfjord teeth, periodontitis

Received: September 2019
Accepted: December 2019

Introduction

Periodontal disease is one of the two major dental diseases that affect human populations worldwide at high prevalence rates. Chronic periodontitis is usually a progressively destructive change leading to loss of bone and periodontal ligament due to the extension of inflammation from gingiva into the adjacent bone and ligament (Page & Korman, 1997).

Generally, the diagnosis of periodontal disease is based on the presence and extent of gingival inflammation, frequently measured as bleeding on probing, probing pocket depth, clinical attachment level, and the pattern and extent of alveolar bone loss assessed radiographically. In addition, consideration may be given to age, gingival recession, tooth mobility, medical and dental histories, previous treatment, and signs and symptoms, including pain, ulceration, and microbial deposits (AAP, 2003).

Increased tooth mobility is both an indicator and outcome of detrimental changes in the periodontium. Clinical and experimental observations have revealed hypermobility as a collective outcome of both loss of alveolar bone and associated qualitative and quantitative alterations in the periodontal ligament and supra-alveolar soft tissue (Persson & Svensson,

1980). An evaluation of patients' tooth mobility is a prerequisite for diagnostic assessments and treatment strategies. Subjective methods where the tooth is deflected between two instrument handles are widely accepted in the clinical routine, but are operator-dependent and non-reproducible (Laser *et al*., 1975).

Objective measurement techniques often require complex experimental setups; however, quantitative information about tooth mobility is feasible. A cost-efficient and time-saving alternative to obtain objective information about tooth mobility is the Periotest method, an accepted technique for diagnostic findings in different dental fields such as Periodontology, Traumatology, Implantology, Oral Surgery or Orthodontics (Goellner *et al*., 2010).The Periotest method (Siemens Dental Division) for determining periodontal function was developed between 1972 and 1984 by an interdisciplinary group of researchers (Schulte *et al*., 1990).

Diagnosis of periodontitis is based on measuring either the loss of connective tissue attachment to the root surface or the loss of alveolar bone crest. The radiograph can be a valuable aid in diagnosis of periodontitis and determining its prognosis and evaluation of its treatment outcome. Bitewing, periapical and panoramic are three radiographic techniques used for the evaluation of the periodontium. Different opinions exist about the best radiographic technique for diagnosis and evaluation of periodontal bone loss (Moradi *et al*., 2010).

The most commonly used approach to diagnose bone behavior around teeth is radiographic bone examination. However, the weakness of both digital periapical radiographs and conventional radiographs are inability to provide early detection of periodontal disease activity and also technique sensitive, high cost, need equipment and private place or room for imaging and also limited in some people like pregnant women. So, to reduce the radiation hazards in such persons, the present study can provide the fact for the estimation of bone loss without taking radiographs for the diagnosis and prognosis determination, and treatment planning of periodontal diseases by using Periotest value or mobility grading and measuring clinical attachment level.

Materials and Methods

Both genders of subjects (age of 35-59 years) with chronic periodontitis attending at the Department of Periodontology, University of Dental Medicine, Yangon was selected. Total number of subjects is 65 and study duration is 1 year.

Subjects aged between 35-59 years old, having Ramfjord teeth and/or substitutable teeth with chronic periodontitis were included in the study. Subjects who had systemic diseases (such as Diabetes Mellitus, Osteoporosis, Paget diseases etc.), osteomyelitis of jaws, pregnancy, hormonal replacement therapy, any malignancy, and teeth of those with periapical lesion, traumatic root fracture and alveolus fracture are excluded in the study.

Miller Relation between Miller's mobility index and Periotest value (PTV) score

- The amount of tooth mobility is displayed by a value called Periotest value (PTV) ranging from –8 to +50, which can be correlated to 4° of tooth mobility reported by the Miller.
- No distinguishable movement is Grade-0 ranging from 8.0 to 9.9 Periotest value.
- First distinguishable sign of movement is Grade-1 ranging from 10.0 to 19.9 Periotest value.

- Crown deviation within 1 mm of the normal position is Grade-2 ranging from 20.0 to 29.9 Periotest value.
- Easily noticeable Mobility and the tooth movement more than 1 mm in any direction or rotation in its socket is Grade 3 ranging 30.0 to 50.0 Periotest value (Chakrapani *et al*., 2015).

After the selection of subjects, the nature and design of the clinical trial was explained to the participants and consent was taken. Then, thorough history taking and clinical examination were done with the measurements of CAL and PDI by using Michigan probe with William's markings, the three measurements from the lingual aspect (mesio-lingual, mid-lingual, disto-lingual) and buccal aspect (disto-buccal, mid-buccal, mesio-buccal) were done on Ramfjord teeth and data were recorded. Measurements of tooth mobility by using Periotest were also done and resulted PTVs results were recorded. Amount of bone loss was measured by taking digital periapical X-rays with Standard parallel technique using Carestream Dental Imaging Software 6.13.0 version or Image J Software 1.37 V on computer and values were recorded. After collecting the data, the results were tabulated and subjected to statistical analysis. Means and standard deviations of data were calculated for each of the Ramfjord teeth with chronic periodontitis. Then, analysis with Pearson correlation-regression test was carried out to correlate the data.

Bone loss can be defined as the difference between the present septal bone height and the assumed normal bone height for any particular patient, bearing in mind that the normal bone height varies with age.

Amount of bone loss can be measured by substracting the septal bone height from normal bone height, whereas, septal bone height is distance between CEJ and crest of alveolar bone. Normal bone height of young adults is 0.96-1.22 mm (Average 1 mm) and normal bone height of old adults is 1.88-2.8 mm (Average 2 mm) (Carranza, 2002).

Amount of bone loss can be measured in percentage by following formula (Schulte *et al*., 1992)

Bone loss = (1 – hi/hg) 100%

Whereas, 'hi' is intra-alveolar root length (for horizontal type of bone loss - from the most coronal portion of interproximal bone to apex of root, for vertical type of bone loss- from base of intra-bony pocket to apex of root, parallel to long axis of tooth). 'hg' is total root length (from CEJ to apex of root, parallel to long axis of tooth) (Whaites, 1992). This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon.

Figure 1. Measurement of Clinical Attachment Level at 31 with Michigan Probe with William's Markings

Figure 2. Detection of Tooth Mobility with Periotest at 24

Statistical Analysis

After data collection, data entry was done by using statistical package for social science (SPSS-16). The data was expressed as the minimal, maximal, mean and standard deviation (SD). Pearson correlation regression test was used to analyze the data.

Results

Table 1. Mean and Standard Deviation of CAL, PDI, Tooth Mobility and Alveolar Bone Loss in Ramfjord Teeth

Tooth number (Ramfjord Teeth)	CAL (mm)	PDI (score)	Tooth mobility (grade)	Bone Loss (mm)	Bone loss (%)
16	3.17± 1.05	4.57± 1.53	0.37± 0.70	1.38± 1.1	27.49± 9.76
21	1.65± 1.09	4.14± 0.35	0.40± 0.72	1.84± 1.29	23.97± 8.79
24	2.01± 1.19	4.2± 0.44	0.45± 0.71	1.33± 1.01	22.6± 7.39
36	2.76 ±1.35	4.34± 0.54	0.26± 0.59	0.94± 1.25	20.82± 10.55
41	3.10 ±1.48	4.58± 0.68	0.88± 0.91	3.10± 1.67	36.78± 11.29
44	2.13 ±1.17	4.25± 0.50	0.26± 0.57	0.95± 0.95	19.83± 7.77

Table 2. Correlation between Tooth Mobility (PTV) and Alveolar Bone Loss (mm) in Ramfjord Teeth of Chronic Periodontitis Patients

Tooth number (Ramfjord Teeth)	r	r^2	*p* value
16	0.253	0.064	0.041*
21	0.455	0.207	<0.001***
24	0.279	0.078	0.024*
36	0.410	0.168	0.001**
41	0.526	0.277	<0.001***
44	0.427	0.183	0.003**

Pearson correlation test

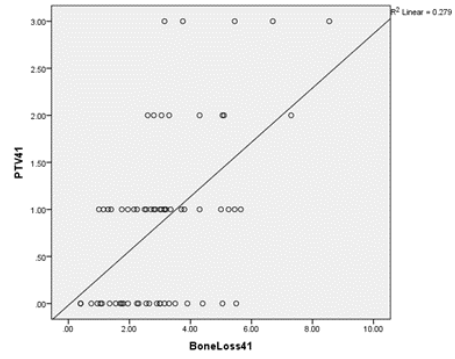

Figure 3. Correlation between PTV and Bone Loss (mm) at 41

Table 3. Correlation between Tooth Mobility (PTV) and Alveolar Bone Loss (%) in Ramfjord Teeth of Chronic Periodontitis Patients

Tooth number	r	r^2	*p* value
16	0.302	0.091	0.015*
21	0.477	0.227	<0.001***
24	0.326	0.106	0.008**
36	0.434	0.188	<0.001***
41	0.560	0.314	<0.001***
44	0.511	0.261	<0.001***

Pearson correlation test

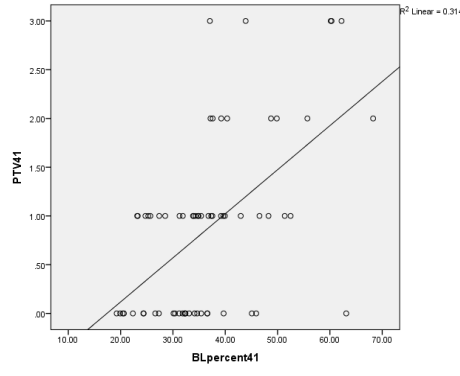

Figure 4. Correlation between PTV and Bone Loss (%) at 41

Discussion

In daily dental practice, dental professionals use both radiographic and clinical parameters measurements to obtain information about the extent of bone loss and for determining the diagnosis and severity of periodontal diseases. Partial mouth examination with appropriate adjustment of Ramfjord index teeth data is useful for assessing periodontal disease progression in longitudinal population studies of human periodontitis (Rams *et al*., 1993). In this study, the results of Ramfjord teeth procedure strongly support conserving time, limiting cost, and reducing patient and examiner fatigue while providing maximal clinical information. However, the Ramfjord teeth assessment was not as suitable for evaluation of either disease extent or prevalence (Dowsett *et al*., 2002).

Digital periapical X-rays are useful for periodontal registration and have a great advantage in giving a precise reading with a lower ionization compared to the conventional intraoral x-rays. Because of that, digital periapical radiographic method was selected in this study. With regard to methodology, digital radiography with paralleling technique was used in the present study for the evaluation of bone loss, whereas earlier studies used conventional intraoral periapical radiographs and bitewing radiographs for the analysis of bone loss.

Increased tooth mobility is a common symptom of advanced form of plaque associated periodontal disease as proved by (Persson & Svensson, 1980).

In the present study, all of the Ramfjord teeth showed significant and positively strong correlation between tooth mobility and alveolar bone loss (mm and %) except 24 and 16 in which there were weak correlations in this study whereas correlation was stronger in 21, 41, 44 and 36 than in 24 and 16. This may be due to greater root surface area and larger connective tissue attachment area in 24 and 16 made those tooth less mobile when compared to the other teeth.

It was more correlated in anterior teeth and in teeth with lesser root surface area than posterior teeth and teeth with greater root surface area. The correlation between the tooth mobility and bone loss was stronger in the mandible than in the maxilla. This difference could be due to the fact that the anterior teeth had a conical single root and less root surface area compared to that of the molars and premolars, which had multiple and curved roots in both arches. Also the root length of the mandibular anterior teeth was less than that of the maxillary anterior teeth, indicating that they had less root surface area compared to the upper anterior teeth. So, the teeth with greater root surface area showed lesser mobility than those with lesser root surface area although there were equal amount of bone loss in such teeth. This meant that the greater the alveolar bone height, the lower the tooth mobility and the greater the alveolar bone loss, the higher the tooth mobility. This explains the fact that the alveolar bone and connective tissue attachment play an important role in maintaining tooth equilibrium.

The present study was consistent with the study of Schulte *et al*., (1990) who showed that the percentage of bone loss was the parameter that was most highly correlated to the Periotest value score.

Although tooth mobility related to clinical attachment loss and bone loss was more significant and correlation was higher in anterior than posterior teeth, mandible than maxilla, the study can provide the fact that amount of bone loss

can be estimated by using Periotest value (PTV) or tooth mobility grading and by measuring clinical attachment level, for the determination of diagnosis, prognosis, treatment planning and outcomes of the periodontal diseases instead of taking radiographs that are also limited in some people due to its unwanted effects.

Conclusion

The efficiency of Periotest as a device to measure tooth mobility is reliable and very well acceptable to the patients, due to its non-invasive and simple design and procedure. Significant correlation between tooth mobility and alveolar bone loss (mm and %) was found in all teeth except 24 and 16 in which weak correlation was occurred. This meant that the greater the alveolar bone height, the lower the tooth mobility and the greater the alveolar bone loss, the higher the tooth mobility.

It was more correlated in anterior teeth than posterior teeth, teeth with lesser root surface area than those with greater root surface area and in the mandible than in the maxilla.

This explains the fact that the alveolar bone and connective tissue attachment play an important role in maintaining tooth equilibrium. The PTV was higher in the incisors when compared with the premolars and molars. Percentage of bone loss was the parameter that was most highly correlated to the Periotest score.

The most commonly used approach to diagnose bone behavior around teeth is radiographic bone examination. However, the weakness of both digital periapical radiographs and conventional radiographs are inability to provide early detection of periodontal disease activity and also technique sensitive, high cost, need equipment and private place or room for imaging and also limited in some people like pregnant women. So, to reduce the radiation hazards in such persons, the present study can provide the fact for the estimation of bone loss without taking radiographs for the diagnosis and prognosis determination, and treatment planning of periodontal diseases by using Periotest value or mobility grading and measuring clinical attachment level.

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The authors declare there is no potential conflict of interest.

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The Efficacy of Locally Delivered *Azadirachta indica* (Neem) Extract Gel in Chronic Periodontitis

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Abstract **- The present study aimed to assess the efficacy of locally delivered *Azadirachta indica* (neem) extract gel as an adjunct to nonsurgical periodontal therapy in the management of chronic periodontitis. Plaque control in periodontics range from mechanical debridement of tooth surfaces by professional scaling and root planing and self-performed plaque removal to local and systemic delivery of chemical antimicrobial agents. In recent times, herbal products as novel drugs are tried in local drug delivery. Neem has multi-various actions like anti-microbial, anti-septic, anti-inflammatory properties. This study was conducted at the Department of Periodontology, University of Dental Medicine, Yangon. A total of 44 sites from 44 subjects with chronic periodontitis were included after obtaining a fully-formed consent and were randomly collected by balanced randomization method into two groups. Study group was treated by scaling and root planing with locally delivered neem extract gel whereas control group was treated by scaling and root planing alone. The clinical parameters [Plaque Index (PlI), Gingival Index (GI), Probing Pocket Depth (PPD), Clinical Attachment Level (CAL)] were recorded at baseline and 6th week after treatment. The results showed improvements in clinical parameters at both study and control sites. On comparison of clinical parameters at baseline and 6th week after treatment, a mean change of PPD of 1.79±0.04 in study group and 1.12±0.04 in control group were observed and statistically high significant difference (p<0.05). This study revealed that the adjunctive use of locally delivered neem extract gel has no known side effects and has promising results.**

Received: September 2019
Accepted: December 2019

Keywords; Azadirachta indica (Neem), local drug delivery, periodontitis

Introduction

Periodontal disease is a complex multifactorial disease characterized by destruction of periodontal tissues and loss of connective tissue attachment (Newman *et al*., 2015). Elimination or adequate suppression of putative periodontopathic microorganisms in the subgingival microbiota is essential for periodontal healing (Eley *et al*., 2010). The standard treatment of periodontitis consists of phase I periodontal therapy with the objective of reducing the total bacterial load and changing the environmental conditions of these microbial niches. Although mechanical treatment (scaling and root planing) reduces the level of subgingival bacteria, it does not eliminate all the pathogens which reside deep into the connective tissue and destroy the bone (Jain *et al*., 2012).

Success of any drug delivery system designed to target periodontal infections depends upon its ability to deliver the

antimicrobial agents to the base of pocket, at a bacteriostatic or bactericidal concentration (Ashtaputre & Limaye, 2014). It has been observed that the local route of drug delivery can attain 100-fold higher concentrations of an antimicrobial agent in subgingival sites compared with a systemic drug regimen thereby reducing the total patient dose by over 400 fold avoiding development of drug-resistant at non-oral body sites (Goodson, 1994).

Various locally delivered agents that are successfully used include tetracycline fibers, 10% doxycycline, 2% minocycline, metronidazole and chlorhexidine gluconate, but none are without side effects. These are expensive and easily not available. Recently, research is being conducted for the use of the natural products. One such natural plant which holds the medicinal value is neem (Jain *et al*., 2012). Oil from the leaves, seed and bark possesses a wide spectrum of antibacterial action against Gram-negative and Gram-positive microorganisms, includeing *Streptococcus mutans, Prevotella intermedia, Capnocytophaga, Fusobacterium nucleatum* and Lactobacillus species (Singh *et al*., 2012).

Neem extract contains (1) Azadirachtin - the active principal compound, (2) glycosides - antimicrobial, (3) sterols, (4) luminols - anti-inflammatory and (5) flavonoids - antioxidant and anti-inflammatory (Moore, 1987). Neem has also shown better efficacy in the treatment of oral infections and plaque growth inhibition in treating periodontal disorders (Pai *et al*., 2004). Based on the assumption of obtaining better efficacy of neem extract in the oral cavity and the properties of ingredients along with the easy availability of neem, with no known adverse reactions and being cost effective, has been selected for this study as a locally delivered agent adjunctive to treatment of periodontitis. Neem leaf extract was formulated in a gel form for the ease of placement and retention at the target site following placement.

Materials and Methods

This randomized control clinical trial was conducted from October, 2015 to September, 2016 at the Department of Periodontology, University of Dental Medicine, Yangon. Subjects were collected from the volunteer patients attending at the Department of Periodontology, University of Dental Medicine, Yangon. Informed consent was obtained from the subjects prior to the study. Neem extract was prepared from the dried leaves of neem collected from the medicinal garden of FAME Pharmaceuticals Industry Co., Ltd, Yangon, Myanmar.

In neem oral gel contained neem extract 25% as active ingredient, carbomer 0.6% as gel base thickener, sorbitol 20% as sweetener, peppermint oil <0.1% as flavor, methylparaben 0.1% as preservative and triethanolamine (TEA) as pH adjuster and water as base. Carbomer was sprinkled in water until thoroughly spread and stirred. The mixture was swelled for 1 hour. TEA was added until pH 6.5 and then gel formed. Sorbitol was added and then, neem extract was also added. Peppermint oil and methylparaben for long shelf-life was added and stirred homogenously. The dosage used was 25 mg to be delivered at the target site.

Systemically healthy 44 subjects including both males and females in the age group of 35-59 years old were selected. Subjects diagnosed to have chronic moderate periodontitis with probing pocket depth 3-5 mm without furcation involvement. Subjects were excluded if they had taken antibiotics two weeks before the study or if they had

received any periodontal treatment in the previous 3 months. Pregnant women, lactating mothers, subjects who had smoking and betel quid chewing habits, subjects with systemic diseases which have adverse effect on periodontal healing such as diabetes mellitus or bleeding disorders and subjects allergic to neem were the other criteria for exclusion.

A total of 44 sites from 44 subjects were randomly collected by balanced randomizing method into two groups, control group and study group. At baseline, thorough history taking and clinical periodontal examination (clinical parameters) were recorded. All study subjects were given scaling and root planing. And then, study group was treated with locally delivered neem extract gel and the treated area was given periodontal pack. The pack was removed after 7 days. On 3rd week follow up, oral hygiene status was checked and oral hygiene measures were reinforced as necessary. And then, on the 6th week follow up, clinical parameters of the selected target sites were recorded.

The following clinical parameters were used to assess the periodontal status; Plaque Index (PlI) (Silness & Loe, 1964), Gingival Index (GI) (Loe & Silness, 1963), Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL). This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon.

Figure 1. Diaflex Syringe with NEEM Extract Gel

Figure 2. Baseline examination

Figure 3. Delivery of Neem extract gel

Statistical Analysis

The data was entered into the computer using Microsoft excel 2007 and statistical analysis was carried out using computer analysis software SPSS (Statistical Package for Social Science) version 20.0. Descriptive and summary statistics were carried out. For the categorical data, frequency and percentage were calculated and for the continuous data, mean and standard deviation were calculated by Chi-Square tests. Statistical significance of differences in two groups were determined by independent t-test. Statistical significance of differences of before and after treatment for each group were determined by pair t-test. Two tailed $p<0.05$ was considered as statistically significant.

Results

All the subjects in both groups have completed the 6-week clinical

evaluation. In both groups, there was decreased in plaque index after treatment and statistically significant (p<0.05). There were no significant changes between two groups on 6th week after study procedure with a 't' test value of -1.68 and it was not statistically significant (Table 1). The mean values of gingival index were fair rating of score. A statistically highly significant reduction in gingival index was observed at both control group and study group after treatment. There were no significant changes between two groups on 6th week after study procedure with a 't' test value of -0.60 and it was not statistically significant (Table 2).

In the present study, both treatments effectively reduced the probing pocket depth (Table 3). Mean PPD score at baseline (2.98±0.39) was reduced to 1.86±0.43 in control group while mean PPD score at baseline (3.31±0.34) was reduced to 1.52±0.43 in study group. On comparison of baseline and 6th week after treatment, a mean change of PPD of 1.12±0.04 in control group and 1.79±0.04 in study group were observed. With a 't' test value of 2.58, it indicated a statistically high significant difference (p<0.05).

There was statistically high significant gain in clinical attachment level in both groups after treatment (Table 4). On comparison of both groups, although there was no statistically significant difference between two groups after treatment, gain in CAL was greater in study group than control group. No patient reported any discomfort in both groups. No adverse reaction was observed in any subject from study group, without any post-application complications.

Table 1. Comparison of mean plaque index between control group and study group at baseline and 6th week after study procedure

Clinical Parameter	Time	Group	N	Mean	±SD	t-test	*p*-value
PII	Baseline	Control Group	22	1.87	±0.34	-0.22	0.82
		Study Group	22	1.89	±0.26		
	6th week after Study Procedure	Control Group	22	0.10	±0.12	-1.68	0.10
		Study Group	22	0.20	±0.26		

Table 2. Comparison of mean gingival index between control group and study group at baseline and 6th week after study procedure

Clinical Parameter	Time	Group	N	Mean	±SD	t-test	*p*-value
GI	Baseline	Control Group	22	1.78	±0.28	-0.70	0.48
		Study Group	22	1.84	±0.23		
	6th week after Study Procedure	Control Group	22	0.09	±0.11	-0.60	0.54
		Study Group	22	0.11	±0.10		

Table 3. Comparison of mean probing pocket depth between control group and study group at baseline and 6th week after study procedure

Clinical Parameter	Time	Group	N	Mean	±SD	t-test	*p*-value
PPD	Baseline	Control Group	22	2.98	±0.39	-2.96	0.55
		Study Group	22	3.31	±0.34		
	6th week after Study Procedure	Control Group	22	1.86	±0.43	2.58	0.01*
		Study Group	22	1.52	±0.43		

Table 4. Comparison of mean clinical attachment level between control group and study group at baseline and 6th week after study procedure

Clinical Parameter	Time	Group	N	Mean	±SD	t-test	*p*-value
CAL	Baseline	Control Group	22	3.68	±0.67	-2.14	0.96
		Study Group	22	4.12	±0.66		
	6th week after Study Procedure	Control Group	22	2.75	±1.06	-0.20	0.83
		Study Group	22	2.81	±0.75		

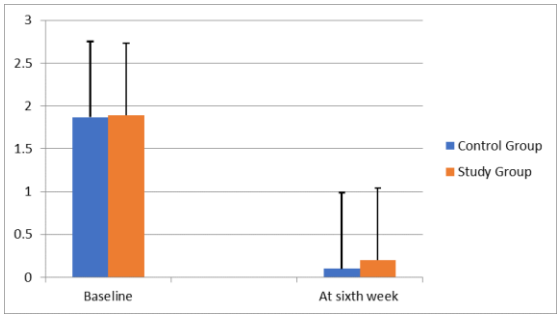

Figure 4. Comparison of mean plaque index between control group and study group at baseline and on 6th week after study procedure

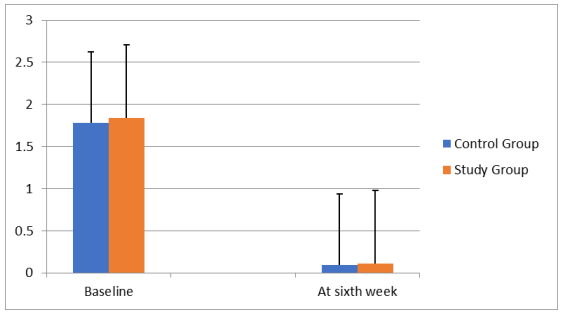

Figure 5. Comparison of mean gingival index between control group and study group at baseline and 6th week after study procedure

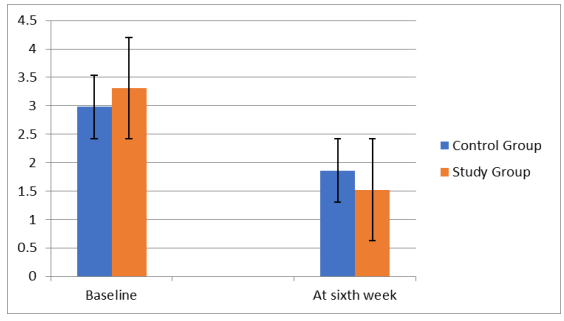

Figure 6. Comparison of mean probing pocket depth between control group and study group at baseline and 6th week after study procedure

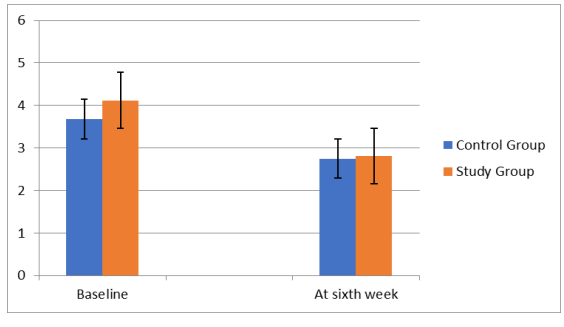

Figure 7. Comparison of mean clinical attachment level between control group and study group at baseline and 6th week after study procedure

Discussion

Extracts of neem, often called "Nature's drugstore", have been used in medicine for over 2500 years and perhaps much longer (Puri, 1999). Neem has multi-various actions like antibacterial, astringent, antiseptic, anti-inflammatory, antiviral and antimicrobial properties. It is easily available and has no known adverse reactions (Jain *et al*., 2012). Locally, it may also have an effect in enhancing healing (Mehta *et al*., 2015). Neem has been used as a locally delivered gel in this study to explore the efficacy in the treatment of patients with chronic periodontitis. Totally in 44 subjects, there

were 18 male and 26 female subjects. Total mean age was 47.91±8.09 years old, minimum was 35 and maximum was 59 years old.

In a 6-week clinical study performed by Pai and coworkers (2004) to evaluate the efficacy of neem extract gel with commercially available chlorhexidine (0.2% w/v) mouthwash as positive control, it was suggested that neem extract gel has significantly (p<0.05) reduced the plaque index (1.588±0.33 at baseline to 0.423 ±0.48) and bacterial count than that of the control group after 6 weeks use of the products.

Jain *et al*., (2012) reported that the clinical evaluation of neem chip showed a statistically significant reduction in probing pocket depth (5.60±0.81 mm, 3.67±0.96 mm, 3.20±0.89 mm at baseline, 6 weeks and 3 months respectively), and a significant reduction in gingival index score was also found at (1.87±0.21 mm from baseline to 1.19±0.30 mm at 3 months) as compared to scaling and root planing alone. There was decrease in plaque index scores and gain in the clinical attachment levels (4.23±0.56 mm at baseline to 3.56±0.67 mm at 3 months) and the results were comparable in both groups at 6 weeks and 3 months evaluation. Though there was gain in the clinical attachment level in both groups but the results were not significant when the two groups were compared at 6th week and at 3rd month after treatment.

In comparative evaluation of the efficacy of neem when incorporated in a local drug delivery system when used as an adjunct to scaling and root planing: a clinico-microbiological study conducted by Mehta and coworkers (2015), PlI, GI and PPD were assessed at baseline, 1 month and 3 months. The results showed reduction in the PPD, GI and PlI as well as the counts of the bacteria in both groups. Mean PPD decreased from 5.81±0.7 at baseline to 3.19±0.3 at 3 months (p<0.05) in neem group.

In the evaluation of the efficacy of neem extract gel as a local drug delivery in the treatment of patients with chronic periodontitis – a double blind randomized clinical trial, Antony *et al*., (2013) recorded the clinical parameters at baseline, 1 month, 3 months and 6 months respectively. The plaque index score showed a statistically highly significant (p<0.000) improvement over a duration of six months. The mean change in PlI at the experimental sites was 0.900±0.25 which was greater than that observed at the control sites (1.350±0.46). A statistically highly significant reduction in GI was observed by a mean change of 0.737±0.24 at experimental site indicated a higher reduction in the GI compared to the control site which showed a mean change of 1.325±0.23 over six months.

On comparison of PPD score of baseline and one month after treatment, it was statistically significant with a 't' test value of 18.38. A statistically highly significant reduction (p<0.000) in PPD and CAL from baseline to 6 months was also noted.

In the present study, it showed that almost all patients maintained a good level of oral hygiene in term of self-performed oral hygiene control measure throughout the study period. This indicated that gingival inflammation and bleeding on probing were improved after treatment. The findings of PlI and GI was consistent with the studies reported by Pai *et al*., (2004), Jain *et al*., (2012) and Antony *et al*., (2013).

The reduction in PPD is more obvious in study group. When the groups were compared to each other at baseline and at 6th week after study procedure, it indicated a statistically high significant difference (p<0.05) between two groups. It can be

assumed that the treatment outcome of study group using neem extract gel showed better efficacy when compared to control group using SRP alone. There was statistically high significant gain in CAL in both groups after treatment. On comparison of both groups, there was no statistically significant difference between two groups after treatment. According to baseline and 6th week measurements, the amount of gain in clinical attachment level in study group was greater than that of gain in clinical attachment level of control group. These results reached consensus with the study conducted by Jain *et al*., (2012) and Antony *et al*., (2013).

Conclusion

The present study cannot be directly compared with the previous studies due to various formulations, difference in composition of neem, different study designs used for evaluation, racial variation and the relatively short duration of the present study involving a small number of subjects. But, the results of all clinical parameters obtained in the present study were in accordance with those of the previous studies where neem extract accelerated healing process through its broad range antibacterial activity.

Within limits superimposed by a relatively smaller sample size, the results demonstrated that both SRP and SRP with neem extract gel produced significant improvements in each group between baseline and follow-up data. The improved clinical resolution of inflammation and destruction in the study group can be explained by the effectiveness of neem extract gel as an anti-inflammatory and antimicrobial agent against periodontal pathogens, which might have prevented microbial recolonization of periodontal pockets.

On comparison between two groups, PlI and GI scores are not significantly different. This may be due to the short term follow up of six weeks and the results showed that there was no difference in plaque deposits and all of the study populations also had similar oral hygiene. The efficacy of neem extract may become better as it was maintained for a longer period of time. This phenomenon helps in maintaining a healthy micro flora for a longer period. Therefore, in future, studies need to be carried out for longer durations with large sample size and also require microbiological analysis for an evidently beneficial clinical outcome. Further standardization of gel formulations should be done and their efficacy should be compared with the gold standard local drug delivery therapeutic agent, chlorhexidine, to evaluate its definitive role in periodontal therapy.

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The authors declare there is no potential conflict of interest.

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Alveolar Ridge Preservation with Hydroxyapatite/beta-tricalcium phosphate-Collagen Composite in Maxillary Anterior Teeth

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Abstract **- The purpose of this study was to compare the dimensional changes (width and height) and healing of alveolar ridge following tooth extraction, with and without placement of hydroxyapatite, beta-tricalcium phosphate collagen (HA/β-TCP-collagen) composite plug. The twenty-four extracted sockets of maxillary anterior teeth were randomly allocated to experimental group with HA/β-TCP-collagen composite plug and control group with extraction alone. The extractions and grafting were performed at the same time without raising a flap nor being covered with barrier membranes. The dimensional changes in width of the ridge were measured clinically by using the alveolar ridge mapper and the changes in height were detected radiographically at before tooth extraction, immediately after tooth extraction and 3 months after the extraction. The healing of the ridge was assessed by Gray Scale and Modified Landry and Turnbull healing index. The greater reduction in width of the alveolar ridge was observed at the control sites (3.67±1.16 mm) compared to the experimental sites (5.83±1.12 mm) during the 3 month follow up period. But the comparison of changes in height of the alveolar ridge between two groups was not statistically significant (*p*=0.551). In comparison of the healing of the ridge between these two groups, the better outcomes were seen in the experimental group with significance level (*p*<0.005). There were no foreign body reactions or complications in this study. In conclusion, the placement of HA/β-TCP-collagen socket plug into the freshly extracted socket could prevent the reduction of the alveolar ridge with the least surgical morbidity and the most promising result.**

Keywords; alveolar ridge preservation, HA/β-TCP-collagen composite, socket grafting

Received: September 2019
Accepted: December 2019

Introduction

Alveolar ridge resorption is a chronic, irreversible phenomenon which continues to resorb throughout life after the extractions (Kotaski *et al*., 2014). If no actions are employed for prevention of this phenomenon, 40%-60% of total alveolar bone volume is lost during the first 2-3 years post extraction, the vast majority of these changes occur during the first 3 months after tooth extraction and this phenomenon continues with a rate of 0.25%-0.5% loss per year (Ashman, 2000).

When immediate dental implant placement is not planned, alveolar socket preservation is a method of choice used to minimize the dimensional changes in soft and hard tissues after extraction (Sadeghi *et al*., 2016). Atraumatic extraction and further protection of alveolus are important to reduce need of additional complex bone and/or soft tissue augmentation procedures

during later dental implant placement procedure (Kubilius *et al*., 2012).

The type of maxillary anterior bone is type III bone, mostly spongy, less cortical and the labial bone is also very thin, which leads to high risk of ridge resorption after tooth extraction. The volumetric reduction and loss of favourable architecture of the alveolar ridge may negatively affect the placement of dental implant and influence the treatment success of a fixed or removable prosthesis in regard to function and aesthetics (Schroop *et al*., 2003). Thus, it would be advisable to protect reduction of the ridge.

The methods to preserve alveolar ridge include guided bone regeneration-GBR (with or without grafting material), grafting with bone substitutes (with or without flaps), and socket seal surgery without primary flap closure (BioCol technique, modified BioCol technique and Nu-men technique with alloplast) (Kotsakis *et al*., 2014).

In GBR, the augmented site needs to be covered with a barrier membrane or an advanced buccal flap. Barrier membranes have drawbacks of primary soft tissue closure, membrane exposure, surgical site infection and second surgery is needed to be removed. It also requires reflection of flap which disturbs the blood supply and causes negative effect on bone remodeling (Mezzomo *et al*., 2011). But the use of synthetic bone plug technique is a flapless procedure and it does not need primary closure, membrane or flap - providing patients with more comfort, no alteration of mucogingival junction and adequate zone of keratinized gingiva which are needed for aesthetics of future dental implant (Kotsakis *et al*., 2014).

Biphasic calcium phosphate ceramics (BCP) consisting of HA and β-TCP (homogenous 60/40 mixture) have the advantage of the different resorption rates of the two materials, achieving a balance between long term stability and support (HA) and more rapid dissolution and bone ingrowth (β-TCP) (Legeros *et al*., 2003). As HA and β-TCP are completely synthetic, they do not require donor sites (available in unlimited quantities) and do not pose a risk of disease transmission although they cannot provide osteogenesis (Jamjoom and Cohen, 2015). But it can also readily be identified on X-ray, being much denser than the adjacent bone, for the radiographic assessment for bone healing (Von Doernberg *et al*., 2006).

The present study was made to compare the dimensional changes and healing of the alveolar ridge, with and without placement of HA/β-TCP-collagen plug, in freshly extracted sockets.

Materials and Methods

Study Population

Twenty-four subjects were selected based on the need of tooth extraction at Department of Oral and Maxillofacial Surgery, University of Dental Medicine, Yangon. The inclusion criteria were both genders with age group between 20-55 years, mentally sound subjects with ASA I and II, non-restorable, maxillary anterior teeth with adjacent teeth present on both sides, and freshly extracted sockets with intact four wall bone after tooth extraction.

Exclusion criteria were medically compromised subjects, pregnant and lactating mothers, use of systemic corticosteroids within 2 weeks, previous head and neck radiation therapy, use of bisphosphonates and immunosuppressants, smokers and betel nut chewers, tooth with severe periodontitis (with a remaining bone height ≤ 6 mm) and tooth associated with presence of acute infection and underlying bony pathology (for example-cysts).

Study Material

The material used in this study was maxresorb® flexbone/collacone® max, a product of Botiss Company, Germany (Figure 1). It is a resorbable synthetic bone plug containing biphasic calcium phosphate (60% hydroxyapatite and 40% beta-tricalcium phosphate) and porcine type I collagen. The macropore size is 200 µm – 800 µm and the porosity is 80%. The diameter of plug is 11 mm and its height is 16 mm.

Preoperative Assessment

At first, the clinical assessment was done to patients with non-restorable maxillary anterior teeth, who attended to Department of Oral and Maxillofacial Surgery from September 2017 to August 2018. The patients entitled to the study according to inclusion criteria were explained about the procedures, outcomes, benefits and complications of the current research. Then, informed consent was taken. Patient's bio-data such as age, gender and past medical history were recorded. Each patient received a diagnostic workup including digital periapical radiographs, study casts, and clinical photographs. Customized vaccum assisted thermoplastic stents were fabricated on study casts to serve as fixed reference points for measurement of width of alveolar ridge. Two holes (at mid-buccal and mid-palatal) as references to measure the width of alveolar ridge were made on the stents at 5mm below the line connecting the cementoenamel junction (CEJ) of the two adjacent teeth.

Operative Procedure

Routine standard operative procedures were performed in both groups. The whole mouth was cleaned with 0.12 percent chlorhexidine solution. The extraction of tooth was performed under local anaesthesia, using lignocaine with adrenaline (1:100,000). All the procedures were performed by the same surgeon. The extraction of the tooth was performed as atraumatically as possible. Care was given to not raise a flap in order to maintain the vascularization of the socket walls. After removal of the tooth, thorough debridement of the extracted socket was made. A Michigan-O-periodontal probe was utilized to explore the buccal plate which had to be intact four-wall post-extraction sockets after tooth extraction. The subjects were divided into two groups according to randomization table. In study group, the synthetic bone plug was inserted into an extraction socket, trimmed to completely occupy the space from the crest of the alveolus to the apex of the socket and stabilized with a figure of eight suture (3/0 vicryl) to prevent it from falling out. In control group, the extracted socket was left open and was not given any pressure to contact the socket walls. Both groups were prescribed postoperative medications- per oral amoxicillin 500 mg for 5 days, per oral acetaminophen 500 mg for 3 days and 0.2 percent chlorhexidine mouth rinse twice a day for 2 weeks. The patients were asked to follow post-operative instructions and medications strictly. After 6^{th} week, the placement of a provisional temporary restoration was made with least trauma to healing ridge, only for optimal aesthetics.

Study Method

The custom-made vaccum-formed thermoplastic stents were placed into the mouth. The width of alveolar ridge was measured at reference holes on these stents (under local anaesthesia) clinically by using the ridge mapper (Figure 2) at baseline, immediate postoperative period and 3 months after tooth extraction (Figure 3). The height of the alveolar ridge was also detected on intraoral digital periapical

X-ray with parallel technique by drawing two lines (first line connecting the cementoenamel junction (CEJ) of two adjacent teeth on each side, second line drawn from the lowest position on alveolar ridge defect perpendicular to the first one). This perpendicular distance was measured at baseline, immediate postoperative period and 3 months after extraction. To detect the alveolar bone healing, gray scale-relative alveolar bone density (mean gray value of the defect region/ mean gray value of the surrounding bone) was analyzed by using image J software (Geiger *et al*., 2016). The soft tissue healing was assessed by the Modified Landry and Turnbull healing index, as shown in Table 1. This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon.

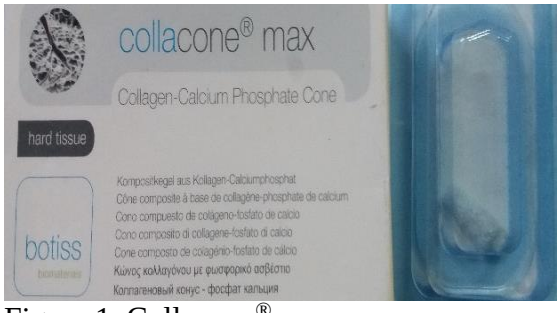

Figure 1. Collacone® max

Figure 2. Alveolar ridge mapper

Figure 3. Measurement of width of alveolar ridge with ridge mapper

Table 1. Modified Landry and Turnbull healing index (Balse & Baliga 2018)

Healing score	Characteristics
1-Very poor	Tissue color: ≥ 50% of gingiva red Response to palpation: bleeding Granulation tissue: present Suppuration: present Presence of Alveolar osteitis
2- Poor	Tissue color: ≥ 50% of gingiva red Response to palpation: bleeding Granulation tissue: present
3- Good	Tissue color: ≥ 25% and ≤ 50% of gingiva red Response to palpation: no bleeding Granulation tissue: none
4-Very good	Tissue color: < 25% gingiva red Response to palpation: no bleeding Granulation tissue: none
5-Excellent	Tissue color: all tissues pink Response to palpation: no bleeding Granulation tissue: none

Statistical Analysis

Statistical Package for Social Sciences (SPSS) 20.0 version Statistical Software was used for data analysis. The data were expressed as in mean and standard deviation (SD) for continuous variables and count and percent for categorical variable. To test the hypothesis of difference between two groups, Fisher's

exact test, Mann-Whitney U-test and paired '*t*' test were used. Statistical significant level was determined at *p*-value <0.05.

Results

Twenty-four subjects were involved in this study and half of them were in the age group 47-55 years. The causes of tooth extractions were dental caries (62.5%), endodontic failure (25%) and traumatic crown fracture (12.5%). The extracted teeth were 21 incisors and 3 canines.

Table 2. Comparison of width (mm) of alveolar ridge at different interval between two groups (n=24)

Time	Alveolar ridge width (in mm) (Mean±SD)		*p*-value*
	Study	Control	
Baseline	5.92±1.08	5.08±0.99	0.101
Immediate	5.92±1.08	5.08±0.99	0.101
3 months	5.83±1.12	3.67±1.16	0.000*
p-value*	0.339	0.000*	

*Mann-Whitney U-test

The mean width of alveolar ridge reduced in both groups at 3 month. The mean width of alveolar ridge decreased from 5.92±1.08 mm to 5.83±1.12 mm in the study group while the mean width of alveolar ridge decreased from 5.08±0.99 mm to 3.67±1.16 mm in control group. The reduction in width of alveolar bone in conventional group was statistically significant in comparison with synthetic bone plug group (*p*=0.000), as shown in Table 2. The reduction of bone width was 27.75% in control group and only 1.52% in study group.

Table 3. Comparison of height (mm) of alveolar ridge at different interval between two groups (n=24)

Time	Alveolar ridge width (in mm) (Mean±SD)		*p*-value*
	Study	Control	
Baseline	3.37±1.26	3.67±1.03	0.443
Immediate	3.37±1.26	3.67±1.03	0.443
3 months	2.67±0.93	2.78±1.18	0.551
p-value*	0.002*	0.000*	

*Mann-Whitney U-test

Reduction in the mean height of alveolar ridge was noted in both groups at 3 month. The mean height of alveolar ridge decreased from 3.367±1.26 mm to 2.667±0.93 mm in study group and from 3.667±1.03 mm to 2.783±1.18 mm in control group. The comparison of height of alveolar ridge at 3 month between groups was not significantly different (*p*=0.551), as shown in Table 3.

Table 4. Comparison of alveolar bone healing (gray scale for relative alveolar bone density) between two groups (n=24)

Time	Relative radiodensity (Mean±SD)		*p*-value*
	Study	Control	
Immediate	0.9696 ±0.15	0.6934 ±0.20	0.001*
3 months	0.8677 ±0.14	0.8334 ±0.144	0.713

* Mann-Whitney U-test

The relative radiodensity (Gray scale) in study group (0.9696±0.15) was significantly higher than control group (0.6934±0.20) at immediate postop, showing that the density of grafted

biphasic calcium phosphate was higher than of the surrounding bone. But at 3 month, it was observed that the radiodensity in study group gradually reduced from 0.9696±0.15 to 0.8677±0.14, indicating that some of the grafted material has resorbed. But the radiodensity of conventional group gradually increased from 0.6934±0.20 to 0.8334±0.14 at 3 month, showing that the radiodensity of naturally healing socket gradually increased with time, as shown in Table 4.

Table 5. Comparison of soft tissue healing between two groups

Soft tissue healing	Study		Control		Total	
	n	%	n	%	n	%
Very poor	-	-	-	-	-	-
Poor	-	-	-	-	-	-
Good	-	-	-	-	-	-
Very good	1	8.3	9	75	10	41.7
Excellent	11	91.7	3	25	14	58.3
Total	12	100	12	100	24	100

*Fisher's exact test

The comparison soft tissue healing between two groups was shown in table 5. According to Fisher's exact test, the comparison of soft tissue healing between these two groups was significant (p=0.003). The results of some of the cases were shown in following photographs.

Figure 4. Grafted socket at 3 months

Figure 5. Comparison of soft tissue healing between control (Right) and study (Left) at 3 months

Figure 6. X-ray of grafted socket at immediate (Right) and 3 months (Left)

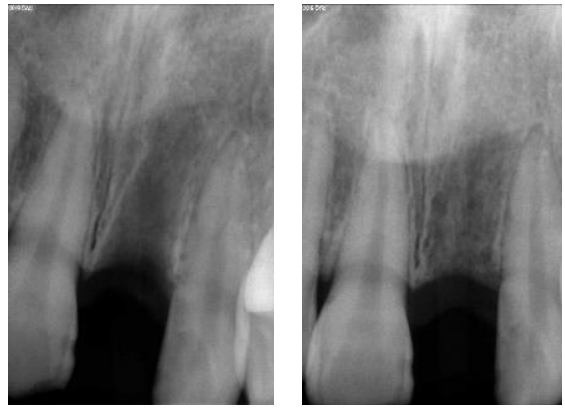

Figure 7. X-ray of control group at immediate (Right) and 3 months (Left)

Discussion

Post-extraction alveolar ridge resorption is an inevitable physiologic process. The alveolar socket wall commonly decreases in volume and changes morphologically following tooth extraction. To

prevent this, the alveolar ridge preservation (socket grafting) techniques have been adopted by dentists throughout the world.

The alveolar ridge preservation (ARP) via socket grafting with HA/β-TCP-collagen composite was chosen in this study due to its biocompatibility, osteoconductive 3D scaffolding, angiogenic abilities of collagen, cell-mediated resorbability. This method was supported by Ho *et al*., (2016) who conducted a comparative study of 4 groups- HA/β-TCP-collagen composite, collagen alone, purified fibrillar collagen and bovine xenograft-collagen into 80 extracted sockets. The smallest width reduction (19.9±8.81%) was observed in HA/β-TCP-collagen composite group.

Moreover, barrier membranes were not used in the present study according to Brkovic *et al.*, (2011) who stated that combination of β-TCP and type I collagen used for simple preservation of a maxillary extraction socket without a barrier membrane resulted in new bone formation (62.6% of mineralized bone and 21.1% of bone marrow) 9 months after the procedure. This was due to inhibition of fibroblastic proliferation into the bone marrow by β-TCP particle metabolites and a local decrease in pH during the chemical dissolution process.

But there is no ideal technique and bone graft material that is suitable in all situations and can provide hundred percent bone preservation. This technique is not appropriate in the presence of acute infection and flaps may need to be raised in cases of severe bone loss, ridge irregularities or socket wall defects (Darby *et al*., 2008).

According to Araújo and Lindhe (2009), Schroop *et al*., (2003) and Moya-Villaescusa and Sanchez-Perez, (2010), the vast majority of alveolar bone volume changes occured first 3 months after tooth extraction although the overall changes may not yet be completed by this time. Thus, the study period was selected for 3 months in the current study and it was found that significant changes in horizontal dimension of ridge occurred in comparison between conventional group and synthetic bone plug group ($p<0.005$).

The alveolar ridge mapping technique used in the present study had sensitivity 59%, specificity 91%, positive predictive value 71% and negative predictive value 90% according to Castro-Ruiz *et al.*, (2015). To assess the changes of alveolar ridge height, cone beam computed tomography (CBCT) is the best and alveolar width can also be measured simultaneously.

The current study revealed that the comparison of reduction in width of alveolar ridge between two groups was significant ($p<0.005$). The amount of reduction of bone width was 27.75% in the control group and only 1.52% in the study group at 3 months after tooth extraction. In regard with height changes, reduction in height of the ridge was found in both groups at 3 months after tooth extraction, but these changes were not significant at inter-group comparison ($p=0.551$).

These findings were in agreement with a similar study conducted by Sachdev *et al.*, (2015) which showed that the amount of loss in bone width in control site was 31.6% after 3 months and a significantly greater alveolar ridge width reduction was noted in control sites (4.0-1.5 mm) compared to experimental sites (2.5-1.0 mm) although the ridge height reduction was not significant. Therefore, ARP with HA/β-TCP-collagen composite plug was effective in limiting physiologic ridge reduction in horizontal dimension as compared with tooth extraction alone although it had no significant effect on

height of the ridge.

In the present study, it was found that the loss in width of the ridge (5.08±0.99 mm to 3.67±1.16 mm) was greater than loss in height (3.667±1.03 mm to 2.783± 1.18 mm) in control group at 3 months after the tooth extraction. These results were in accordance with a systematic review of alveolar bone dimensional changes of post-extraction sockets in humans by Van der Weijden *et al.,* (2009) which stated that the clinical loss of thickness (3.87 mm) was greater than the loss in height when evaluated both clinically (1.67-2.03 mm) and radio-graphically (1.53 mm) at 6 months after tooth extraction and also consistent with Lekovic *et al.,* (1997) who reported that loss of width was three times greater than loss of height following tooth extraction. Thus, to protect the width loss is more necessary than to protect the height.

In this study, the densitinometric analysis of extracted sockets was done by using software on digital intraoral periapical X-ray. In synthetic bone plug group, the decrease in relative radiodensity (from 0.9696±0.15 to 0.8677±0.14) was noted at 3 months after the procedure, indicating that some of the grafted material has resorbed. The result was in accordance with the studies conducted by Von Doerberg *et al.,* (2006), Horowitz *et al.,* (2009) and Pe'rez A'lvarezn *et al.,* (2016). As the grafted material had resorbed and preserved the dimension of alveolar ridge, it would provide favourable conditions for placement of dental implant with subsequent loading in the 4 to 6 month period.

In the current study, the soft tissue healing was assessed by Modified Landry and Turnbull healing index. The difference of soft tissue healing between the two groups was statistically significant (p= 0.003). Moreover, one patient in the present study had two maxillary anterior teeth which were indicated for extraction. These two teeth were simultaneously extracted and these two extracted sockets were compared, with and without grafting. At 3 months, it was found that healing of grafted socket were better than naturally healed socket, even in the same patient.

Girard *et al*., (2000) reported a case of a foreign body granuloma with pain and sensation disturbance following placement of a graft into an extraction socket, already compromised by the previous infection. In the present study, the teeth without acute infection have been selected and the extracted sockets were made thorough debridement before grafting to prevent presence of granulation tissues and foreign bodies. So, there were no foreign body reactions and complications in this study.

Conclusion

The alveolar ridge preservation (ARP) concepts are well accepted throughout the world and there are many still ongoing researches about ARP. The results of this study showed that ARP via socket grafting with HA/β-TCP-collagen composite plug can be a minimally invasive and effective method to prevent post-extraction physio-logic ridge resorption in horizontal dimension although it has less effect on vertical dimension. But there is also a necessity for long term study in large number of population to assess changes of the ridge following preservation and the success rate of osteointegration of dental implant within the grafted socket.

COI

The authors declare there is no potential conflict of interest.

Acknowledgments

This work is supported by Imple-

mentation Research Grant (8/2018) of Department of Medical Research, Ministry of Health and Sports.

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Platysma Flap Reconstruction in Oral Squamous Cell Carcinoma of Tongue: Cases Report

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Abstract **- Cancer is the one of the most common causes of morbidity and mortality. In Myanmar, oral cancer stood 6th and 10th position in male and female respectively, contributing 3.5% of the whole - body cancers. The two main goals of cancer therapy are to achieve a disease - free physical state of health and acceptable quality of life. After surgical resection of tumours, oral cavity will result in severe functional impairment of the individual patient. Numerous options can be used for reconstruction of the head and neck, including primary closure, skin grafts, local flaps and free flaps. Platysma myocutaneous flap (PMF) is one of the cervical pedicle flaps and it was first used for the reconstruction of oral defects in 1978 by Futrell. PMF is readily available, easy to harvest, thin and pliable, promoting three-dimensional reconstruction, ease in closure the donor site primarily, minimal donor site morbidity and appropriate flap thickness for oral defects. So, PMF is the alternative use from free flap in intraoral defects.**

Keywords; platysma myocutaneous flap, reconstruction, oral cancer of tongue

Received: October 2019
Accepted: December 2019

Introduction

Oral cancer is a multifactorial disease and the incidence of oral cancer in Myanmar is high because the etiology of oral cancer such as tobacco and betel chewing are habits of Myanmar people. In Myanmar, among oral cancer patients, 68.7% are tobacco chewers or smokers and 11.7% are betel and tobacco chewers (Oo *et al*., 2010). In UK, head and neck cancer represents 5 to 10 % of all tumours making it the 8th most common cancer in male and 16th most frequent in female (Watkinson *et al*., 2012). In Myanmar, oral cancer represents 6th position in male and 10th in female respectively.

The two main goals of cancer therapy are to achieve a disease free physical state of health and an acceptable quality of life. Treatment modalities are surgery, radiotherapy, chemotherapy and other such as lasers, immunotherapy and gene therapy.

Aim of cancer surgery is to resect the tumour and leave tumour free surgical border (Pagani *et al*., 2007). After surgical resection of tumours of oral cavity will results in severe functional impairment of the individual patient. Head and neck surgery often have dramatic functional effects on speech, respiration, swallowing and alimentation and the surgical site is often highly visible, leading to unique challenges for the reconstruction. Therefore, adequate functional reconstruction of both hard and soft tissue defects plays a key role in the surgical treatment of head and neck tumours (Eckardt, 2013). The patient's quality of life is improved by reconstruction of anatomic defects following cancer surgery.

Various reconstructive techniques are available, including primary closure, skin

grafts, pedicle flaps and free flaps but all of these techniques have their limitation (Li *et al*., 2013). Currently, the most commonly used reconstruction technique is microvascular free flap. However, free flaps are not suitable for all patients undergoing a surgical operation. Microvascular free flaps require lengthy surgery, experienced surgeons in microsurgery, microsurgery equipment and a second donor site (Rufat *et al*., 2014).

As one of the cervical pedicle flaps, the platysma myocutaneous flap was firstly used for the reconstruction of oral defects in 1978 (Peng *et al*., 2005). Platysma myocutaneous flap (PMF) is a satisfactory reconstructive option for small and medium sized defects in the oral cavity. The PMF was introduced for intraoral reconstruction by Futrell in 1978. PMF is readily available, easy to harvest, thin and pliable, promoting three-dimensional reconstruction, ease in closing the donor site primarily, minimal donor site morbidity and appropriate flap thickness for oral defects (Tosco *et al*., 2012).

Three different variations of the myocutaneous island platysma flap are available based on the dominant blood supply. Inferiorly base flap with arterial supply from transverse cervical artery, which finds no application in oral reconstruction. Posteriorly based flap with arterial supply from the occipital and posterior auricular arteries and venous supply is external jugular vein. In this version of the platysma flap, it is not possible to maintain the cervical branch of the facial nerve. Wide exposure of muscle is important to access and measure the arc of rotation into the surgical defect.

Superiorly based flap with arterial blood supply from the submental artery which is the largest branch of the facial artery. Superiorly based flap is suitable for reconstruction of the anterior and lateral floor of mouth, tongue, buccal mucosa, retromolar trigone and lower alveolar ridge (Lazaridis *et al*., 2007).

Hence, the blood supply has been called ‘multi-axial’ and rapid shift of route of perfusion after skin incision to compensate for interrupted routes has been invoked (Koch, 2002). When the facial artery is ligated, there is retrograde filling of the platysma system through both ipsilateral internal and external carotid contributions as well as contra-lateral external carotid contributions through the labial arch (Li *et al*., 2013).

According to literature, skin paddle of maximal size is approximately 7 cm x 12 cm (Handa *et al*., 1989). It is a horizontal ellipse which needs 180-270 degrees of rotation for intraoral reconstruction. In the version, a vertical ellipse provides more versatility for rotation with less tension and kinking. This paddle can be used anteriorly or posteriorly with 90-180 degrees of rotation (Saito *et al*., 1998). For the vertical flaps, the maximum size is 12 cm x 5.5 cm and minimum is 7 cm x 5 cm (Li *et al*., 2013).

The purpose of this report is to present platysma myocutaneous flap is an attract-tive recon-structive option and alternative use from free flap in intraoral soft tissue defect.

Cases and Methods

Ten patients with oral squamous cell carcinoma (OSCC) of tongue were treated with platysma myocutaneous flap reconstruction after excision of primary tumour and neck dissection at the Department of Oral and Maxillofacial Surgery, University of Dental Medicine, Yangon. The patients had involved five of men and five of women with the age range of 39 to 60 years. Staging of the cases were six of $T_2N_0M_x$ and four of $T_3N_0M_x$.

Surgical Technique

The size of the vertical platysma myocutaneous flap was outlined and raised in the ipsilateral neck of the defect to be repaired and incision line was connected with that of the neck dissection. Supraomohyoid neck dissection was taken in all cases. The flap pedicle was usually located 1.5 cm to 2 cm below the lower border of the mandible. The plane of elevation should include the sternocleidomastoid fascia as well as the external jugular vein to provide adequate venous drainage. After excision of tumour and neck dissection, PMF was rotated superiorly and sutured into position through the tunnel under the mandible, which should be sufficiently wide. The epidermis was removed from the part of the flap located into the tunnel. Primary defect of the tongue was reconstructed with PMF. The neck incision was closed primarily.

Table 1. Characteristics of patients, site and staging of tumours and use of flap size

Case	Age, Sex Staging	Site	Size of Flap (cm x cm)
1	39 yrs, F $T_2N_0M_0$	Tongue (Rt)	5x10
2	50 yrs, M $T_2N_0M_0$	Tip of Ventral Tongue	5x11
3	51 yrs, M $T_2N_0M_0$	Tongue (Lt)	5x9
4	41 yrs, F $T_3N_0M_0$	Tongue (Lt)	5x11
5	51 yrs, M $T_2N_0M_0$	Tongue (Rt)	5x9
6	42 yrs, M $T_3N_0M_0$	Tongue (Lt)	5x11
7	55 yrs, F $T_2N_0M_0$	Tongue (Rt)	5x11
8	52 yrs, F $T_3N_0M_0$	Tongue (Lt)	5x11
9	57 yrs, F $T_3N_0M_0$	Tongue (Lt)	5x10
10	52 yrs, M $T_2N_0M_0$	Tongue (Lt)	5x12

Table 2. Outcomes related to the flap and others complications

Outcomes related to the flap				
Full Viability	Partial Necrosis	Total Necrosis	Fistula	Hypertrophic Scar at Donor Site
7	3	-	-	1

Results

Intraorally the skin paddle was healed without any problems and allowed for adequate tongue mobility. The dimensions of skin flap were used in range from 5 x 9 cm in minimum and 5 x 12 cm in maximum (Table 1). In all patients the reconstruction was performed as a single stage procedure together with tumour resection (Figure 2) and supraomohyoid neck dissection (Figure 3). The donor site was closed primarily and without complications and neck movement but one of the cases had hypertrophic scar. Three cases had partial flap necrosis but managed by local measures such as surgical wound debridement of necrotic tissue. No complications were found as fistula, wound infection and dehiscence and donor sites morbidity (Table 2).

Figure 1. Oral SCC tongue at right lateral border of tongue

Figure 2. Wide excision of tongue

Figure 5. Harvesting with platysma flap

Figure 3. Supraomohyoid neck dissection

Figure 6. Post-operative 1st month

Figure 4. Raising of Platysma Flap

Figure 7. Acceptable donor site healing

Discussion

The goal of reconstruction is restoration of form and function to allow a good quality of life. Malthes and Nahai described "Reconstructive Ladder" in 1982 ranging from primary closures to skin grafts, local flaps, distal flaps, and free flaps.

Reconstruction of tongue is very important because of its pivotal role in speech, swallowing and airway protection. The ideal tissue selected for reconstruction should be versatile in design, adequate in tissue stock, provide consistent texture with minimal donor site morbidity. Therefore, reconstructive options should attempt to maintain mobility or to provide bulk and should be determined based on size of the defect, tissue loss, donor site availability and the patient's ability to withstand prolong general anesthesia.

Since 1983, the free radial forearm flap (FRFF) has been considered the first choice for the restoration of tongue defect. Recently, the anterolateral thigh flap has challenged the superiority of FRFF because it does not necessitate a skin graft and involve the sacrifice of an artery or possible damage to the tendons of the hand. According to literature, in case of contraindications for microsurgery, pedicle flaps such as pectoralis major myocutaneous flap, facial artery musculo-mucosal flap or submental artery island flap might be considered as good reconstructive options.

In all cases, superiorly based PMF had been used in intraoral defects reconstruction with preservation of facial artery. Uehara *et al*., (2001) described the reason for flap success, in cases which the facial artery was ligated, is the retrograde flow from the distal submental artery anastomoses to either the lingual artery or the contralateral facial artery.

Because the blood supply to the skin island does not strictly depend on musculocutaneous perforating vessels, this flap is mostly fasciocutaneous with little muscle. Furthermore, it is easy to transfer because of its adequate arc of rotation 90 to 180 degree. This flap provides good residual mobility, swallowing and speech for tongue reconstruction. Pliability of the flap allows later shaping so as to allow dental prosthetic rehabilitation. Therefore, rough tissue handling, tension, pedicle kinking or compression, or minimization of the pedicled fasciocutaneous paddle should be avoided, which are compromised the tenous vascular perforators and result in partial or total flap loss.

Conclusion

The ideal tongue reconstruction would provide identical size, shape, sensation, taste, mobility and coordinated articulation and swallowing function in a single procedure. As the result of this study, PMF was effective and alternative use for reconstruction of medium size defect oral squamous cell carcinoma of tongue.

COI

The authors declare there is no potential conflict of interest.

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Dental Service Use and Dentition Status among 12 year-old Schoolchildren in East District, Yangon Region

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Abstract **- Good oral health is an essential part of better general health and well-being throughout life. Regular dental visit has been found to provide an opportunity for oral health care professionals to diagnose illness, provide primary preventive services and treat particular dental disease and other oral health related problems. The aim of this study was to assess dental service use and dentition status among 12 year-old schoolchildren in two townships from East District, Yangon Region. Cross-sectional, descriptive, school-based, non-intervention type of study was carried out among 482 (250 boys and 232 girls) schoolchildren in 2017-18. Data concerning socio-demographic characteristics, dental visit pattern and dentition status were determined. The present sample was likely to represent urban population and nearly half of their parents had only completed primary and middle school education. Almost the same distribution pattern of education was found between fathers and mothers. Two third of fathers (65.6%) and one third of mothers (30.7%) were unskilled workers and more than half of mothers (55.4%) were dependent. History of dental service utilization was reported in 42.9% of students and main reason was toothache (52.2%). Among those who had visited to the dentist (n=207), most of them (86.5%) visited to the private dental surgeons and 65.2% had received treatment of tooth extraction. Approximately 40.0% of students acquired oral health knowledge from dental surgeon. Most of the students (92.9%) responded that they should see the dental surgeon at least once a year for routine dental checkup. Dental caries prevalence was 67.0% with mean DMF-T of 0.65 (SD 1.16) where decayed was a dominant portion. No relation-ships were observed between dental caries and gender, parental education, parental occupation, dental visiting pattern. However, higher caries prevalence was found in schoolchildren with lower mothers' educational level. In addition, lower level of dental visit pattern was observed among those with low parental educational level. Thus preventive as well as curative measures should be promoted along with school dental health program.**

Keywords; dentition status, dental caries, dental service use, 12 year-old schoolchildren

Received: October 2019
Accepted: December 2019

Introduction

Good oral health is an essential part of better general health and well-being throughout life. Relationship between oral and general health is documented in several research findings. Maintaining good oral health is vital because the burden of oral disease is manifested in poor nutrition, school absences, missed workdays and increasing public and private expenditures for dental care. Better health

is important not only for the quality of life of an individual but also for economic growth and sustainable development of entire nation (Byrne, 2004).

Tooth decay is a major oral health problem and the most prevalent oral disease among children in the world (Viswanath & Sabu, 2014; Mathur *et al*., 2016) and it can greatly affect a child's daily life. Nowadays, several parts of world are facing with tooth decay and Center of Disease Control (CDC, 2010) estimated that more than half of the US children aged 12-15 years old experienced dental caries. More importantly, untreated decays are major and remaining problem in developing countries (Viswanath & Sabu, 2014). The global average DMF-T for 12 year-old schoolchildren was 1.67 and its prevalence was 78%. In Asia, the mean numbers of DMF-T for 12 year-old schoolchildren were Singapore (0.6) was the lowest, Japan (1.4), Cambodia (3.5) and Philippines (3.3) in 2011 respectively (Cheng, 2014).

Dental visit is one of the influences for oral health status of an individual as well as population group. Dental service utilization can be defined as "the percentage of the population who access dental services over a specified period of time" (Craft & Croucher, 1980; Brown, 1999). Regular dental visit has been found to provide an opportunity for oral health care professionals to diagnose illness, provide primary preventive services and treat particular dental disease and other oral health related problems (Macek *et al*., 2005). The studies hypothesized regular use of oral health care services has contributed substantially to healthy mouths for both children and adults.

Oral health objectives for healthy people 2010 call for an increase in the proportion of those aged 2 years or older who use the oral health care system at least once a year and an increase in the proportion of low income people younger than 19 years of age who are known to be at a higher risk for disease (Macek *et al*., 2005). In Myanmar, oral health care is provided and organized by both private and public providers. The Ministry of Health and Sports is taking the responsibility of providing comprehensive oral health care services in all hospitals and school health teams. Township Hospitals and School Health Teams are providing health care services including primary oral health care services and also acting as the first referral health institutions for those who required dental care. More advanced secondary and tertiary health care services are provided at the Region/ State Level hospitals, Central and Teaching hospitals (MOHS, 2016).

Most often children from low income or minority families have problems receiving the care they need. Some of the serious factors identified to limit access to dental care for these children include lack of finances, lack of transportation, language and cultural barriers and lack of perceived need for care (Kanello, 1999; Denloye *et al*., 2010). Studies demonstrated that importance of service utilization among cohort of student population so as to enable dental professionals plan programs that will ensure equity in access to oral care (Ogini, 2004; Oredugba, 2006; Ajayi & Ajayi, 2007) and suggsted to conduct utilization research among young adolescents with a view of assessing their views and beliefs on the regular use of oral health care services.

Different figures of dental service use were demonstrated in many studies where over 80 percent of 13 to 14 year-old junior secondary students from Nigeria and 25 to 50 percent of university students from some ASEAN countries were never been to the dentists (Denloye *et al*., 2010;

Peltzer & Pengpid, 2017). There is a little amount of data concerning utilization of oral health care services and availability of school oral health services among schoolchildren in Myanmar. Moreover, there is only few data relating to the availability and accessibility of oral health care services not only from the public sector but also from the private sectors.

Twelve year-olds are important as they are likely to have all the permanent teeth except the last molars and the group has been chosen for the global indicator age group for international comparisons and surveillance of oral disease trends (WHO, 2013). In addition, the schoolchildren have some competency to respond questions about health service uses and can give examples for oral health promotion and establishment of effective referral system for student population. So, the present study was aimed to study the dental service utilization pattern and dentition status among 12 year-old schoolchildren from two townships in the East District, Yangon Region. The findings available from this study can facilitate and strengthening school oral health program for promoting oral health of future generation.

Materials and Methods

A cross-sectional, descriptive, school-based, non-intervention type of study was carried out in Thingangyun and Dagon Seikkan Townships, East District, Yangon Region from November 2017 to January 2018. After getting agreement from the respective educational authorities, one Basic Education High School from each selected township was chosen randomly and explained the procedure to the heads of the schools. With the help of the teachers, all eligible 12 year-old schoolchildren were selected according to the inclusion criteria and asking for the consent from both students and guardians. The study included 482 students of both genders who were 12 year-old in their last birthday.

After getting the consent, the investigator asked a participant about socio-demographic data and utilization questionnaire (including 10 questions) by using face to face interview method in a prepared room. Then, students were examined to assess dentition status using decayed, missing and filled teeth index (DMF-T index) applying WHO (2013) criteria. The examination was performed by the examiner and a trained recorder under natural day light. The infection control guidelines recommended by WHO (2013) were used throughout. To prevent any disturbances from their learning schedule, data collection was carried out during their lunch-time hour.

Collected data were cleansed and entered in Statistical Package for Social Sciences (SPSS) (version 22.0). Data analysis was done accordingly. The continuous variables were expressed by means and standard deviations and the categorical variables were described by frequencies and percent and analyzed by Chi-square test.

Ethical Consideration

This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon. The informed consent form was sent prior to examination. After describing detailed procedure of this research, participants were asked for sign to the consent. The collected data were kept confidential. Any participant with necessary treatment was referred to the University of Dental Medicine, Yangon.

Statistical Analysis

The continuous and categorical vari-

ables were expressed by t-test and Chi-square. Statistical analyses were performed using Statistical Package for Social Science (SPSS) (version 22.0). Statistical significances were considered at $p<0.05$. (Confidence interval 95%).

Results

In this study, 482 twelve year-old schoolchildren (250 boys and 232 girls) were participated. Regarding ethnicity, 87.1% reported as Bamar and foreign blood such as Chinese and Indian, was the second most common ethnic group (7.5%). The socio-demographic attributes i.e. educational level and occupations of their parents were shown in Table 1. The present sample was mostly represented urban population and nearly half of their parents had completed primary and middle school education. Almost the same distribution pattern of education was found between fathers and mothers. Two third of fathers (65.6%) and one third of mothers (30.7%) were unskilled workers and more than half of mothers (55.4%) were dependent.

Less than half of students (42.9%) had visited dental clinic and dental visit behavior was shown in Figure 1 and Table 2. History of dental service utilization was reported in 42.9% of students and among them (n=207), main reason was toothache (52.2%). Among those who had visited to the dentist (n=207), most of them (86.5%) visited to the private dental surgeons and 65.2% had received treatment of tooth extraction.

Relating to dentition status, prevalence of dental caries was 31.6% in boys and 34.5% in girls with mean DMF-T were 0.64 (SD 1.18) and 0.66 (SD 1.15) (Table 3). There were no statistical associations between dental caries experience and gender, parental education level and occupation, dental service utilization pattern of the participants. However, higher caries prevalence was found in schoolchildren with lower maternal educational level. In addition, lower numbers of dental visit were observed among those who parental educational level was low (Table 5).

Table 1. Distribution of schoolchildren by socio-demographic attributes (n=482)

Socio-demographic attributes	School children n (%)
Fathers' education level	
Can read and write, no formal education	23 (4.8)
Primary school education	63 (13.1)
Completed primary school education	
Completed middle school education	114 (23.7)
Completed high school education	109 (22.6)
Graduated	54 (11.2)
Don't know	67 (13.9)
	52 (10.8)
Mothers' education level	
Can read and write, no formal education	22 (4.6)
Primary school education	75 (15.6)
Completed primary school education	
Completed middle school education	108 (22.4)
Completed high school education	114 (23.7)
Graduated	45 (9.3)
Don't know	74 (15.4)
	44 (9.1)
Fathers' occupation	
Unskilled worker	316 (65.6)
Farmer	15 (3.1)
Government servant	27 (5.6)
Professional	13 (2.7)
Dependent	8 (1.7)
Merchant	24 (5.)
Others	79 (16.5)
Mothers' occupation	
Unskilled worker	148 (30.7)
Farmer	8 (1.7)
Government servant	18 (3.7)
Professional	4 (0.8)
Dependent	267 (55.4)
Merchant	9 (1.9)
Others	28 (5.7)

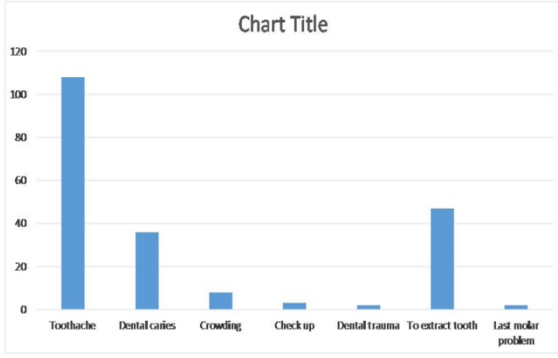

Figure 1. Reason of dental visit (n=207)

Table 2. Dental visit behavior of school-children (n=207)

Dental visit behavior	School Children n (%)
Type of service provider	
Dental surgeon from school health	10 (4.8)
Township dental surgeon	11 (5.3)
Private dental surgeon	179 (86.5)
Charity dental clinic	5 (2.4)
University of Dental Medicine, Yangon	2 (1.0)
Type of treatment received	
Tooth extraction	135 (65.2)
Dressing	32 (15.5)
Filling	31 (15.0)
Scaling	1 (0.5)
Orthodontic treatment	3 (1.4)
Routine dental check up	5 (2.4)

Table 3. Dentition status of schoolchildren (n=482)

Dentition status	Male	Female	Total
Mean D (SD)	0.61 (1.15)	0.64 (1.11)	0.62 (1.13)
Mean M (SD)	0.03 (0.22)	0.01 (0.11)	0.02 (0.18)
Mean F (SD)	0	0.01 (0.11)	0.01 (0.08)
Mean DMFT (SD)	0.64 (1.18)	0.66 (1.15)	0.65 (1.16)
Caries prevalence (%)	79 (31.6)	80 (34.5)	159 (33.0)

Table 4. Proportion of dental caries experience among school children by gender, location, father's and mother's education (n=482)

	Dental caries experience		X^2	*p* value
	Presence n (%)	Absence n (%)		
Gender				
Male	79 (31.6)	171 (68.4)	0.452	0.501
Female	80 (34.5)	152 (65.5)		
Location				
Urban	137 (33.2)	276 (66.8)	0.044	0.833
Rural	22 (31.9)	47 (68.1)		
Father's education				
High	67 (29.1)	163 (70.9)	2.961	0.085
Low	92 (36.5)	160 (63.5)		
Mother's education				
High	64 (27.5)	169 (72.5)	6.216	0.013*
Low	95 (38.2)	154 (61.8)		

* Statistically significant

Table 5. Proportion of dental service utilization among school children by gender, location, father's and mother's education (n=482)

	Dental service utilization		X^2	*p* value
	Presence n (%)	Absence n (%)		
Gender				
Male	109 (43.6)	141 (56.4)	0.091	0.763
Female	98 (42.2)	134 (57.8)		
Location				
Urban	182 (44.1)	231 (55.9)	1.482	0.224
Rural	25 (36.2)	44 (63.8)		
Father's education				
High	119 (51.7)	111 (48.3)	13.882	<0.001*
Low	88 (34.9)	164 (65.1)		
Mother's education				
High	126 (54.1)	107 (45.9)	22.808	<0.001*
Low	81 (32.5)	168 (67.5)		

* Statistically significant

Discussion

The regular use of oral health care services has contributed substantially to oral health among millions of children and adults (Macek *et al.*, 2005). The present study aimed to assess the pattern of dental

service use among 12 year-old schoolchildren in Yangon Region. Data concerning socio-demographic characteristics, dental service uses and dentition status were collected. Since the study was carried out in Thingangyun and Dagon Seikkan Townships of the East District, the present sample was likely to represent urban population.

In this study, the same distribution pattern of education was found between fathers and mothers. Only a quarter of fathers (25.1%) and mothers (24.7%) were completed high school and half of them were graduated. Almost two third of fathers (65.6%) and one third of mothers (30.7%) were unskilled workers and more than half of mothers (55.4%) were dependent. Therefore, the present sample might represent the lower and lower middle socioeconomic status.

More than half of the participants (57.1%) had never been to the dentist in the present study. One study from Brazil demonstrated that only 15.0% of 12 year-old schoolchildren were not used dental services (Menezes, 2010). The main reason of dental visit in this study was toothache. Among those who had visited to the dentist (n=207), most of them (86.5%) visited to the private dental surgeons and 65.2% had received treatment of tooth extraction, followed by dressing (15.5%) and filling (15.0%). The present sample might show the pattern of dental visiting only when they suffered pain. However, dental visit pattern of other population groups from different geographical regions should also be assessed.

Dental caries prevalence was 33.0% with mean DMF-T of 0.65 (SD 1.16) where decayed was a dominant portion. Dental caries status was not different between boys and girls. According to the WHO, the level of dental caries in this study group was in very low category. The present findings were not different from larger studies where mean DMFT was 0.74 (MDA, 2006) and 0.80 (Aung *et al*., 2018) respectively. Similarly, the present finding of caries prevalence (33.0%) was not much different from previous studies where caries prevalence for 12 year-old children were 51.9% (MDA, 2006) and 34.8% (Aung *et al.*, 2018) respectively. Dental caries experience in Myanmar might not change significantly in the last two decades.

In the present study, the socio-demographic characteristics did not relate to both dental caries status and dental service utilization. However, lower dental service utilization was observed among students with low parental educational levels. The participants in this study reported that very low level of school dental health services utilization. Most of them (179 out of 207) (86.5%) visited to the private dental clinic. Thus preventive as well as curative measures should be promoted along with school dental health program. The results of this study may point out the current situation and suggestion of future strengthening of school oral health program in Myanmar.

Conclusion

Low levels of dental caries status and dental service use were observed among 12 year-old schoolchildren in this study. Pattern of dental visit only when suffering pain and visit to the private was also observed. Thus, strengthening of school oral health care including promotion of oral health education session should be implemented in Myanmar.

COI

The authors declare there is no potential conflict of interest.

Acknowledgments

We would like to express our deepest gratitude to the students and teachers who participated in this study. This study was supported by Implementation Research Grant (ID-280/17) from Ministry of Health and Sports.

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Efficacy of the Autofluorescence-based Imaging System (VELscope™) in Detection of Oral Potentially Malignant Disorders

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Abstract **- The occurrence of oral potentially malignant disorders (OPMDs) has ascended in developing countries where the usage of betel quid chewing and tobacco is accustomed. Despite the developing advanced treatment procedures, malignant transformation rate of some of the OPMDs is considerably high (4 to 18%) according to the recent studies. Hence, adjunctive diagnostic aids for early detection of oral cancer have been developed to help the practitioners in identifying high-risk OPMDs. VELscope™ is a one of the diagnostic adjuncts, which is non-invasive, handheld device designed to visualize early mucosal changes using the principles of tissue autofluorescence. The objective of the study was to determine the efficacy of VELscope™ in detection of OPMDs. Fifty-seven patients with OPMDs seeking treatment at University of Dental Medicine, Yangon were included in this study. After obtaining the informed consent, detailed clinical history was taken and thorough conventional oral examination (COE) was performed. The area of OPMDs was visualized by VELscope™ and the fluorescent visualization loss (FVL) was recorded. An incisional biopsy was performed at the FVL area for histopathological examination. VELscope™ results and histopathological results were compared and sensitivity and specificity were calculated. Mean age of the patients in this study were 37.54±12.78 and male to female ratio was 2:1. According to this study, sensitivity of VELscope™ was 94.4% and specificity was 23.8%. Positive predictive value was 68.0% and negative predictive value was 71.4%. Results of the study revealed that VELscope™ has an optimistic potential as a clinical auxiliary method in detecting OPMDs before performing a biopsy. This device may be an effective adjunct in community oral cancer screening when used with proper clinical judgment. This study suggests for future studies with two scenarios: first with larger sample size, for instance, population-based oral cancer screening and the second with hospital-based clinical studies with determination of marginal clearance using VELscope™.**

Key words; oral potentially malignant disorders, VELscope, autofluorescence

Received: September 2019
Accepted: December 2019

Introduction

Oral malignancy and oral potentially malignant disorders (OPMDs) are major economic and clinical burden for the health care around the world (Ferlay *et al.*, 2013). Incidence of oral cancer; most common is oral squamous cell carcinoma (OSCC), is

still high in developing countries where the prevalence of key risk factors such as use of tobacco and alcohol remains high. Five-year survival rate of oral cancer varies from 81% for patients with localized disease to 42% for those with regional disease to 17% if distant metastases are present (Fedele *et al*., 2009). In Myanmar, oral cancer stands at the sixth position in males and the tenth position in females, contributing to 3.5% of all body cancers (Htun-Naing-Oo *et al*., 2011). Oral cancer (OSCC) often arises from OPMDs such as erythroplakia, leukoplakia, oral submucous fibrosis and oral lichen planus (Gaikwad *et al*., 2013).

Opportunistic screening of OSCCs and OPMDs by conventional oral examination (COE) at dental practices will identify the OPMDs and other mucosal disorders with similar clinical presentations. However, it is estimated that up to 15% of the general population have oral mucosal diseases at one time, but only very few have characteristics of OPMDs. Further, histological evidence of dysplasia and micro-invasive carcinoma has been found in clinically normal mucosa. Therefore, several chair-side adjunctive aids have been developed to help the practitioners with the aim of diagnosing high risk OPMDs from other oral mucosal lesions with similar clinical presentations (Scully *et al*., 2008).

VELscope^{TM} (Visually enhanced lesion scope, LED Medical Diagnostics Inc., Branabym, Canada) is based on the principles of tissue autofluorescence, generally recognized as a non-invasive, hand-held device designed to visualize early mucosal changes especially for OPMDs. The device emits the blue light between 400 and 460 nm wavelengths to excite fluorophores intrinsic in the oral mucosa. Within those excitation wavelengths, unaltered normal mucosa appears as a pale green autofluorescence which can be viewed through a selective, narrow band filter. Dysplastic tissue appears darker in color in comparison to surrounding healthy tissue because of alternative distribution pattern of tissue fluorophores and that is now recognized as fluorescent visualization loss (FVL) (Betz *et al*., 2002).

Several studies have been conducted on the efficacy of VELscope^{TM} on detection of OPMDs as well as oral malignant lesions with variable sensitivity and specificity value (Awan *et al*., 2011, Koch *et al*., 2011, Rana *et al*., 2012, Hanken *et al*., 2013, Sawan & Mashlah, 2015 and Ganga *et al*., 2017). In addition, it was said that routine VELscope use has been challenged because this particular device does not support all of the principles of evidence-based decision-making (Balevi, 2007). Regarding peer-reviewed VELscope studies, many have been performed on patients with known oral dysplasia or OSCC confirmed by biopsy. And several criticisms have been emphasized on this device because it needs to train dentists to use, thus this device has the limited capacity to use by general dentist (Laronde *et al*., 2007, Mascitti *et al*., 2018).

There was no previous study on the efficacy of autofluorescence devices used for detection of OPMDs in Myanmar. The results of this study will support in community-based survey on the early detection and screening of oral cancer and further improve the survival of oral cancer patients. Hence, the aim of this study was to evaluate the efficacy of the autofluorescence-based imaging system (VELscope^{TM}) in detection of OPMDs. To fulfill the main objectives, this study has also described the demographic features of OPMDs in Myanmar patients and further explored the association between the

findings of autofluorescence and histological examinations.

Materials and Methods

This study is an institutional and laboratory based cross-sectional descriptive study. Study population is a total of 57 OPMD patients collected by using convenient sampling method and sample size calculation was based on the study of Warren *et al*., (2007). Department of Oral Medicine and Department of Oral and Maxillofacial Surgery, University of Dental Medicine, Yangon were selected as study areas and study period was one year.

Data Collection Methods and Tools

Selection of the OPMD patients was based on the inclusion criteria. Patients with clinically diagnosed OPMDs were included in this study, recorded with oral mucosal assessment form and obtained informed consents for ethical consideration. Oral squamous cell carcinoma patients were also studied for positive control. Patients who deny to incisional biopsy and patients who are unfit for surgical procedures were excluded.

Conventional Oral Examination and Autofluorescence Examination

A total of 57 patients with a clinical diagnosis of OPMDs and OSCCs presenting to Department of Oral Medicine were screened and obtained the informed consent. Following history taking, the conventional oral examination (COE) was performed under incandescent light source and the data were recorded on the assessment form.

The principal site of morphologically altered tissue was photographed. Autofluorescence examination was performed using VELscope™ under the dimmed room light. The patient was requested to wear protective eye wear throughout the procedure. Autofluorescence examination was performed two times by two different operators from Department of Oral Medicine. The fluorescence visualization loss (FVL) seen as the dark area was marked and followed by incisional biopsy.

Histopathology Examination

Fluorescent visualization loss (FVL) areas of OPMDs were evaluated by incisional biopsy after autofluorescence imaging. For histopathological diagnosis, routine processing and paraffin embedding were performed on each incised soft tissue specimen. 4 µm thick sections were cut from each paraffin block and stained with haematoxylin and eosin. The slides were examined under a light microscope by two oral pathologists, and the results were blinded to each other. Epithelial dysplasia was assessed on architectural and cytological changes according to World Health Organization (WHO) Classification 2005 (Barnes *et al*., 2005).

Data Management and Analysis

Data entry and analysis were performed according to Statistical Package for Social Software (SPSS) version 20.0. Comparison of results of autofluorescence and histopathology were presented in a cross tabulation and agreement of the results were calculated using Kappa statistics. Sensitivity and specificity was calculated for statistical evaluation of the VELscope™ results comparing to incisional biopsy results as gold standard method. The true and false positives and negatives were applied on basic of Habib *et al*. (2015).

Sensitivity, specificity, positive predictive value and negative values were described with their 95% confidence interval. Differences and associations

between the autofluorescence test and dysplasia grade were examined using Chi square test with significance set at $p<0.05$. A receiver operating characteristic curve (ROC) was used to estimate the diagnostic value of the test.

Ethical Consideration

This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon. For ethical consideration, only the patients who gave an informed consent on their own wishes were included in the study. For the safety precaution, necessary preoperative blood investigations were performed and only the patients who were fit to undergo surgical procedures were studied. The expenses for preoperative blood investigations, incisional biopsy procedures and histopathologic diagnostic procedures were supported form external grant of Department of Medical Research, Ministry of Health and Sports, Myanmar. After the study procedures, appropriate treatment and referral for these patients were done in accordance with the histopathological diagnoses.

Results and Discussion

This study was conducted on 57 OPMD patients seeking treatment at Department of Oral Medicine, University of Dental Medicine, Yangon. In this study, male and female ratio was about 2:1 with a mean age of 37.54±12.78 (Figure 1). Interestingly, within the male patients with OPMDs, highest age group belongs to 21 to 30 year age group. This younger male predominance pointed out the accustomed smoking and betel quid chewing habit in younger generation in recent years. In olden days, betel chewing is accepted as traditionally habit among male population. There is an increased popularity of betel quid chewing habit and a huge blooming of betel quid market in many major cities of Myanmar, and because of that patients with OPMDs upraised highest frequency in today.

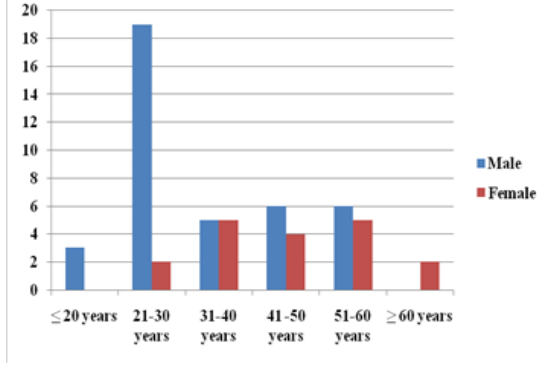

Figure 1. Age and sex distribution of the patient with OPMDs (n=57)

Out of 57 OPMD patients, majority of patients (63.2%) had oral submucous fibrosis followed by oral lichen planus (19.3%) and oral leukoplakia (8.8%) (Table 1). According to these findings, there was a higher proportion of oral submucous fibrosis patients which is mainly caused by betel quid chewing habit in this study reflects increased consumption and addiction of betel quids in Myanmar.

Table 1. Distribution of the clinical diagnosis of OPMD patients in the study

Clinical diagnosis of OPMDs	n (%)
Oral submucous fibrosis	36 (63.2)
Oral lichen planus	11 (19.3)
Leukoplakia	5 (8.8)
Lichenoid reaction	2 (3.5)
Erythroplakia	1 (1.8)
Chronic unhealed ulcer	2 (3.5)

Table 2. Comparison between the VELscope™ results and histopathological findings among the study populations (n=57)

VELscope™ Results	Histopathological Findings		Total
	Dysplasia Positive	Dysplasia Negative	
VELscope™ Positive	34	16	50
VELscope™ Negative	2	5	7
Total	36	21	57

(Sensitivity = 94.4%, Specificity = 23.8%, Positive predictive value = 68.0%, Negative predictive value = 71.4 %)

The sensitivity, specificity, positive predictive value and negative predictive value were calculated by comparing VELscope™ results and incisional biopsy results. Sensitivity of 94.4%, specificity of 23.8%, positive predictive value of 68.0% and negative predictive value of 71.4% were revealed (Table 2). Koch *et al*., (2011) showed a higher sensitivity (96.8%) and specificity of (95.8%) of VELscope™ to diagnose OSCC. Awan *et al*. (2011) evaluated 126 OPMD patients with VELscope™ and observed high sensitivity (84.1%) and low specificity (21.4%) using WHO criteria. Rana *et al*., (2012) showed that using the VELscope™ leads to higher sensitivity (100% versus 17%), but a lower specificity (74% versus 97%) as compared to COE. On the other hand, Hanken *et al*. (2013) examined 120 patients with suspicious oral lesions and found VELscope™ has a higher sensitivity (22.0%), and a lower specificity (8.4%). Sawan and Mashlah (2015) revealed low sensitivity (74.1%) and high specificity (96.3%) in the hospital-based study with the 748 Syrian populations.

In the present study, 16 cases show positive VELscope™ results although no sign of dysplasia was noted in histological examination. These false positive findings in the current study might be due to the inclusion of oral lichen planus, which is caused by chronic inflammatory auto-immune reaction rather than cellular changes. Two specimens were assessed as false negative. Histopathologically, aforementioned false negative cases were assessed as severe epithelial dysplasia although FVL was not apparent. These cases are clinically noted as erythroplakia and oral lichen planus, which are macroscopically suspected lesion area for high malignant transformation.

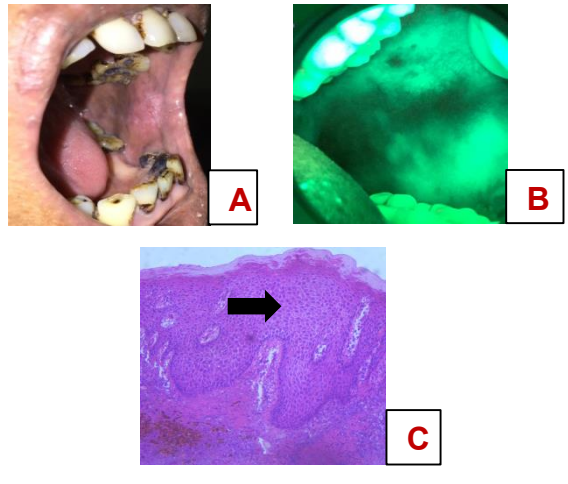

Figure 2. Clinical and histological pictures of oral leukoplakia
2-A. Oral leukoplakia
2-B. VELscope™ results on the lesion (Yellow arrow = abnormal mucosa with VFL: Visual fluorescence loss, Black arrow = normal mucosa)
2-C. Histopathological Results showing epithelial dysplasia (H&E stain x 100)

In the current study, all the OPMDs were firstly examined using VELscope™ and area of visualization fluorescence loss (VFL) were examined by incisional biopsy (Figure 2). This representative mucosal

biopsy of the oral cavity showed dysplastic squamous epithelium (Figure 2) and a high-grade epithelial dysplasia. In comparison, the dysplasia on epithelium showed a loss of maturation and nuclear atypia, high nuclear-to-cytoplasmic ratio and nuclear irregularity, involving the whole squamous cell layer of the mucosa. However, invasive tumour growth was not found.

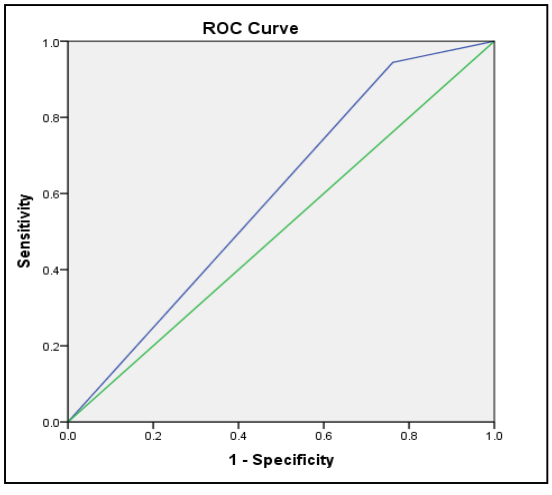

Figure 3. Receiver operating characteristic (ROC) curve for VELscope™ (AUC = 0.591, 95% CI: 0.432-0.751, *p*=0.254)

When sensitivity of VELscope™ examination was plotted against its specificity in ROC curve, the diagnostic value of VELscope™ was detected to be low (AUC=0.591, 95% CI: 0.432-0.751, *p*=0.254) (Figure 3). Results of this study pointed out that VELscope™ examination is a non-invasive procedure which provides a real-time result; it can be applied in patients who are contraindicated for biopsy due to several uncontrolled systemic diseases. However, due to several false positive results from FVL not only in dysplastic cases but also in inflammatory lesions demanded careful clinical judgment is essential for the proper use of VELscope™. It should be only be used in patients without clinically dangerous-looking lesion which are not indicated for biopsy and histopathological examination.

Conclusion

Findings from this study added to the growing evidence that supports the use of VELscope™ as adjunctive oral cancer screening device. However, a good clinical judgment and careful case selection are essential to detect early cancerous changes in OPMDs and high-risk lesions. To augment the efficacy of VELscope™ in early detection of oral cancer, it can be combined with vital tissue staining with toluidine blue. This device allows for a simple and cost-effective marginal determination in suspicious lesions during COE, monitoring oral lesions, and guiding the biopsy. It was found that the VELscope™ could not totally replace the gold standard, histopathology procedure. Therefore, this device may add sensitivity to the oral tissue examination and be an effective adjunct for high-risk patients. In addition, it could be applied in detection of field alterations in tumor margins of oral cancer patients during surgical procedures. Thus, this study further highlighted the diverse fields to perform as future researches; for community-based researches with larger sample size should be carried out to determine efficacy of VELscope™ in detection of OPMDs as well as for hospital-based clinical study to identify subclinical high-risk fields with cancerous and precancerous changes in oral cancer patients.

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The authors declare there is no potential conflict of interest.

Acknowledgements

The authors would like to express sincere thanks all the participants of the study. This study was supported by External Grant of DMR (ID-21/2017) from Department of Medical Research, Ministry of Health and Sports.

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Study on Accuracy of Digital Scanning and Conventional Methods in Partially Edentulous Dental Impression

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***Abstract* - Intraoral impression making is a basic technique in dental practice that is used to generate an imprint of the oral situation. Inaccurate impression may result in prosthesis misfit, which may lead to mechanical and/or biological complications. The current gold standard is the physical impression made with an elastomeric impression material. Recently, the advent of digital technology is developing expeditiously. Digital impressions have emerged as alternative to conventional impression technique and materials. The purpose of this *in vivo* study was to compare the accuracy of digital scanning and conventional techniques in partially edentulous dental impressions. Complete-arch impressions were obtained using two conventional (polyvinyl siloxane, PVS; direct scannable condensational silicone, S-CS) and one digital (3Shape Trios, TRI) techniques. The cast measurements were compared with intraoral measurements. No significant differences in trueness and precision were found between digital impression and conventional silicone impressions (p>0.05). Within the limitations of this *in vivo* study, digital intraoral impression systems showed similar accuracy comparable to highly accurate conventional impression techniques. These techniques can also provide excellent clinical results within their indications and can be used as alternative to conventional impression techniques.**

Keywords; Keywords; digital scanner, dental impression, polyvinyl siloxane impression

Received: October 2019
Accepted: December 2019

Introduction

Precise impression is critical for fabricating dental restorations with adequate fit (Wostmann *et al*., 2009). Since poor quality impressions can compromise the quality of restorations, detailed information on appropriate impression techniques is required for long-term clinical success (Reich *et al*., 2008). Numerous sources of inaccuracy can develop during conventional impression making, among which are the selection of type, size, and rigidity of impression tray, the application of tray adhesive, impression technique, and manipulation of the impression material. Again, errors inevitably occur when creating the cast from conventional impression. Errors are also caused by the impression materials used, expansion and shrinkage of the gypsum cast and impression distortion (Christensen, 2009).

The 'setting' of the impressions generally occurs dimensional changes which affects the accuracy. Many impression materials contain volatile substances as primary components or byproducts of the setting reactions. Loss of such volatile materials during storage results in a shrinkage of the impression material with a consequent decrease in accuracy. For greatest accuracy, dimen-

sional changes should be minimal (McCabe & Storer, 1981).

Elastomeric impression materials can be stretched or compressed slightly, and they can rebound when the impression tray is removed from the mouth. They are capable of accurately reproducing both the hard and soft structures of the mouth, including the undercuts and interproximal spaces. The extent of the rebound determines the accuracy of the material (Anusavice, 2013). The current gold standard is the physical impression made with an elastomeric impression material and stock or custom trays, resulting in a physical gypsum cast (Ender & Mehl, 2013). Elastomeric impression materials are used extensively to prepare casts for fixed and removable partial dentures, as well as for single restorative units, such as crowns, onlays, and inlays (Anusavice, 2013).

The fast and continuous advances digital technology gives clinicians the option to use intraoral scanner (IOS) in place of conventional impression technique. Digital processes are applied for prosthetic-driven backward planning of implant surgery, orthodontic measurements and treatment planning combined with surgical planning (Metzger *et al*., 2008). Digital models are produced by digitizing the oral structures, either directly or indirectly, with intra or extraoral scanners, respectively. The direct method is scanning the oral cavity, whereas the indirect method is scanning an impression or cast. The digital data obtained from the scans are converted into stereolithography (STL) files, a format compatible with computer software. Restorations can then be directly produced. Moreover, digitalized casts can also be converted into actual casts if needed by using 3-D manufacturing.

Recently, digital impressions have emerged as an alternative to conventional impression techniques and materials. Clinical evaluation of intraoral digital impressions has shown very promising results and can eliminate the errors encounter in conventional impressions (Christensen, 2009). Digital impressions have several advantages over conventional impressions, (1) patient will more comfort and much more pleasant experience in the dentist's chair (2) reduction of patient stress and discomfort (3) tend to reduce visits and retreatment while increasing treatment effectiveness (4) time-efficient, data reproducibility and can simplify clinical procedures (5) eliminate plaster models, saving time and space (6) allow for better communication with dental technician and (7) improve communication with patients (Baheti *et al*., 2015; Ender *et al*., 2016).

However, disadvantages are difficulty in detecting deep margin lines in prepared teeth and/or in the case of bleeding. Additionally, purchasing and managing costs are relatively high. Currently, there are seven existing intraoral scanning devices: iTero, Lava Chairside Oral Scanner, Care stream dental's CS 3500, True Definition scanner, The Lythos scanner, 3Shape's Trios and Sirona's CEREC (Baheti, 2015).

Several impression materials and techniques have been investigated in vitro and show a high level of accuracy, however only a few in vivo studies have been conducted (DeLong *et al*., 2003). The accuracy of a dental impression is determined by two factors: "trueness" and "precision". Trueness is defined as the deviation of the impression geometry from the original geometry. Precision is defined as the deviation between repeated impressions rather than to the original geometry. Precision reflects the degree of deviation between impressions within a test group (Ender, 2016). The purpose of

this study is to compare the accuracy of digital scanning methods (intra and extraoral scanners) and conventional standard silicone impression method.

Materials and Methods

Eight partially edentulous patients who are seeking prosthetic treatment at the Department of Prosthodontics, University of Dental Medicine, Yangon were collected according to inclusion criteria. Inclusion criteria are (1) Patients who agree to participate in this study and who gave the informed consent, (2) Patients with age between 15 to 35 years of both sexes, (3) Patients with well-defined canine cusp tips and non-functional cusp tip of first molar (Mesiobuccal for upper and mesiolingual for lower) and (4) Partially edentulous patients (Kennedy Class III- missing one first permanent molar, right or left side). Patients with severe crowding and dentofacial deformity and patients with temporo -mandibular problems were excluded in this study.

The maxillary or mandibular jaw was selected in each subject to test all impression methods. Before impression, the teeth were prepared to make a point to be measured. For each impression group, 3 impressions will be made of each jaw.

Conventional impression was performed by using standard perforated metal rim lock stock trays. The optimal tray was selected by rehearsing a stock tray in the oral cavity while ensuring adequate space for the impression material. The conventional impressions were made using polyvinyl siloxane (PVS) and scannable condensational silicone (S-CS) according to the manufacturers' instruction. Then, making the casts by using stone from PVS impressions.

Digital impression system was made by intraoral scanning device, 3Shape Trios Pod (3Shape Trios, Germany). Digital 3D dental casts from intraoral scanner and S-CS impressions were produced by digital 3D dental cast printer (ASIGA).

Measurements were taken by using digital caliper on the casts. Three measurements were made i.e. (1) intercanine width, (2) edentulous span length and (3) diagonal measurement of canine tip to non-functional cusp tip of first molar. All measurements were carried out 3 times for each distance in stone casts of PVS and 3D dental casts of S-CS and intraoral digital scanner. Mean measurements were recorded. Intraoral measurements were made by using divider and measurements were recorded as mentioned above.

This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon (ERC/UDMY/2019/007). Informed consents were obtained from all subjects participating in the study after thorough explanation of the study procedures.

Figure 1. Impression taking with intraoral scanner (IOS)

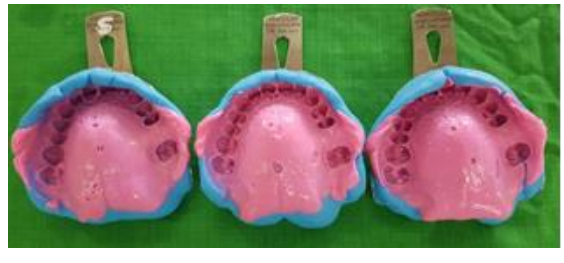

Figure 2. Impression making with polyvinyl siloxane (PVS)

Figure 3. Impression making with scannable condensational silicone (S-CS)

Statistical Analysis

The continuous variables were described by mean and standard deviation. Statistical analyses were performed using Statistical Package for Social Science (SPSS) (version 22.0) for One-way ANOVA test and Intraclass Correlation Coefficient (ICC) to detect trueness and precision. Statistical significance was considered at $p<0.05$.

Results

Table 1. Comparison of mean deviation of inter-canine distance (C-C) among study impression methods (n=21)

Impression methods	Mean (SD)	*F* statistics (df)	*p* value*
IOS	-0.35 (0.81)	0.095	0.910
S-CS	-0.21 (0.89)		
PVS	-0.17 (0.72)		

*One-way ANOVA

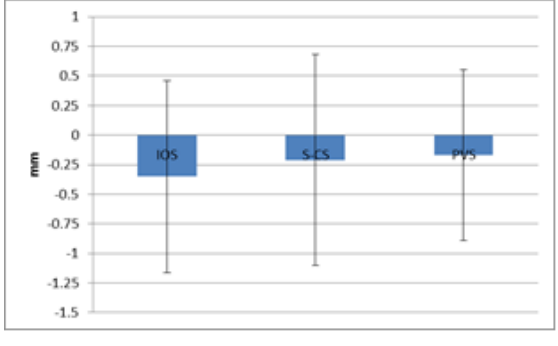

Figure 4. Mean deviation of inter-canine distance among study impression methods

Table 2. Comparison of mean deviation of canine-molar distance (C-M) among study impression methods (n=21)

Impression methods	Mean (SD)	*F* statistics (df)	*p* value*
IOS	0.16 (1.19)	0.028	0.927
S-CS	0.30 (1.28)		
PVS	0.27 (0.92)		

*One-way ANOVA

Since $p>0.05$, there is no significant difference of mean deviation of canine-molar distance (C-M) among different study impression methods.

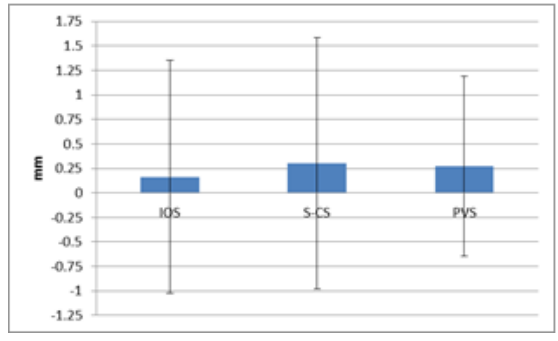

Figure 5. Mean deviation of canine-molar distance among study impression methods

Table 3. Comparison of mean deviation of edentulous span length (ESL) among study impression methods (n=21)

Impression methods	Mean (SD)	*F* statistics (df)	*p* value*
IOS	-0.54 (0.96)	0.623	0.548
S-CS	-0.65 (0.96)		
PVS	-0.17 (0.56)		

*One-way ANOVA

Since $p>0.05$, there is no significant difference of mean deviation of edentulous span length (ESL) among different study impression methods.

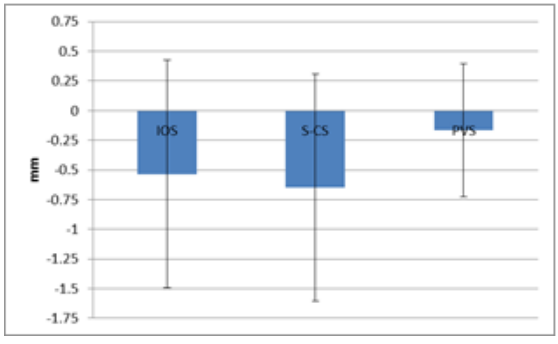

Figure 6. Mean deviation of edentulous span length (ESL) among study impression methods

Table 4. Mean deviation of different distances among study impression methods (n=63)

	IOS	S-CS	PVS
C-C	-0.35	-0.21	-0.17
C-M	0.16	0.30	0.27
ESL	-0.54	-0.65	-0.17

The distance C-M (canine-molar) of casts fabricated from intra-oral scanning gets the lowest mean deviation value among the other distances.

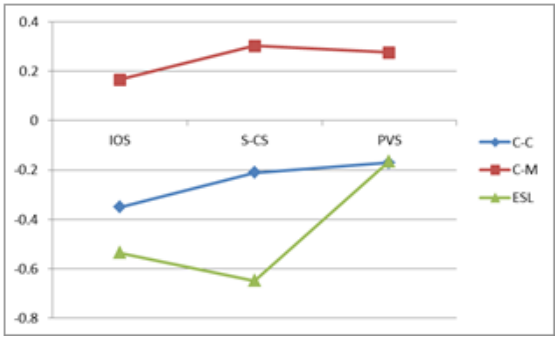

Figure 7. Mean deviation of different distances among study impression methods

Table 5. Intra class correlation coefficient of different study impression methods for distance C-C (n=63)

	Intra class Correlation	95% Confidence interval	
		Lower bound	Upper bound
IOS	0.996	0.986	0.999
S-CS	0.998	0.994	1.000
PVS	0.997	0.989	0.999

The ICC results of study impression methods IOS, S-CS and PVS for C-C are 0.996, 0.998 and 0.997 with 95% confident interval = 0.986-0.999, 0.994-1.000 and 0.989-0.999, respectively.

Table 6. Intra class correlation coefficient of different study impression methods for distance C-M (n=63)

	Intra class Correlation	95% Confidence interval	
		Lower bound	Upper bound
IOS	0.999	0.995	1.000
S-CS	0.999	0.995	1.000
PVS	0.999	0.996	1.000

The ICC results of study impression methods IOS, S-CS and PVS for C-M are 0.999 with 95% confident interval = 0.995-1.000, 0.995-1.000 and 0.996-1.000, respectively.

Table 7. Intra class correlation coefficient of different study impression methods for distance ESL (n=63)

	Intra class Correlation	95% Confidence interval	
		Lower bound	Upper bound
IOS	0.993	0.973	0.999
S-CS	0.995	0.981	0.999
PVS	0.994	0.978	0.999

The ICC results of study impression methods IOS, S-CS and PVS for ESL are 0.993, 0.995 and 0.994 with 95% confident interval = 0.973-0.999, 0.981-0.999 and 0.978-0.999, respectively.

Based on these ICC results, it can be concluded that the reliability of study impression methods is excellent.

Discussion

Clinical indications of intraoral scanner in Prosthodontics and Implantology are resins, inlays/onlays, all ceramic frameworks and fixed partial dentures in zirconia (4-8 elements), single-implant crowns, implant bridges (4-5 implants), posts and cores, partial removable dentures, digital smile design, obturators and guided implant surgery. Contraindications are long-span fixed partial dentures and/or fixed full arches (6-8 elements), long-span implant-supported fixed partial dentures and/or fixed full arches (6-8 implants) and complete removable prostheses (Mangano *et al*., 2017).

The trueness of conventional impressions is commonly tested by measuring the change in linear distance between an original master model and a gypsum cast derived from the impression. This procedure is difficult to perform intraorally and many *in vivo* studies used an indirect approach and verify the impression trueness by measuring the fit of the definitive restoration based on that impression (Seelbach *et al.*, 2013). The present study investigated the accuracy of casts produced by the digital and conventional impression and cast fabrication methods.

For trueness, there are no significant differences of mean deviations of inter-canine distance (C-C), canine-molar distance (C-M), and edentulous span length (ESL) among different study impression methods since $p>0.05$. Conventional impression and cast fabrication methods showed the statistically superior accuracy and reproducibility of complete arch casts than digital impression methods (Cho *et al*., 2015). However, in terms of short edentulous span length area, no statistically significant difference was found between the two methods in this study. Another study showed that working dies made by conventional impression methods were significantly more accurate than those obtained through digital impression. However, no significant difference was found in accuracy on the marginal form areas of the dies (Kim *et al*., 2013). The differences in the current results with Kim's works may be attributed to the use of different conventional impression materials and procedures and to different digital impression methods. Guth *et al.*, (2013) reported that the intraoral Lava COS system showed significantly higher accuracy than the conventional impression procedure and indirect digitalization. The resolution of a scanner affected its ability to read the sharp contours of a scanned surface but did not affect its general trueness or precision. The different technologies (light, laser, or contact) do not affect scanners' overall reliability, but specific aspects of the scanning procedure do (Gonzalez & Martinez-Rus, 2016).

In this study, the intra class correlation coefficient results of study impression methods IOS, S-CS and PVS for ESL are 0.993, 0.995 and 0.994 with 95% confident interval = 0.973-0.999, 0.981-0.999 and 0.978-0.999 respectively. Based on these ICC results, it can be stated that the reliability of all study impression methods is excellent. However, intraoral conditions such as saliva, powder, and limited space could contribute to inaccuracies in the digital scan.

Conclusion

Within the limitations of this *in vivo* study, digital intraoral impression systems showed similar accuracy comparable to highly accurate conventional impression techniques. This technique can also provide excellent clinical results within their indications and can be used as alternative to conventional impression technique.

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The authors declare there is no potential conflict of interest.

Acknowledgments

The authors would like to express sincere thanks to all the participants of the study. This work is supported by External Grant (ID – 101/2019) of Department of Medical Research, Ministry of Health and Sports.

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Effects of Chemical Disinfections on Dimensional Stability of Irreversible Hydrocolloid Impression

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Abstract **- This study was carried out to determine the linear dimensional stability of irreversible hydrocolloid impression materials on resulting dental stone casts after being immersed in two market available chemical disinfectants. Thirty impression samples for each of the two different alginates were taken from a maxillary acrylic model and then immersed in 1% alkylbenzyldimethylammonium chloride (ADBAC) for 3 minutes and 0.5% NaOCl for 10 minutes respectively. Selected measurements were made on the stone casts retrieved from each impression materials. The measurements were analyzed by using independent t test; for comparison among groups. Level of significance was set at $p<0.05$. Linear dimensions of all tested alginate impressions had changed after immersion in each chemical disinfectant. But these changes were clinically acceptable even for the least stable in dimension (maximum deviation 0.39 mm). Therefore, 1% alkylbenzyldimethylammonium chloride (ADBAC) should be considered as chemical disinfectant of choice for immersion disinfection of irreversible hydrocolloid impression material like the recommended chemical disinfectant, 0.5% sodium hypochlorite.**

Keywords; Chemical Disinfections, linear dimensional stability, alginate impression material, sodium hypochlorite, alkylbenzyldimethylammonium chloride

Received: September 2019
Accepted: December 2019

Introduction

Awareness of the potential for spread of microorganisms and disease in the dental treatment has increased significantly and, resulted in a continuing effort to identify and eliminate possible routes for transmission and cross-contamination of diseases such as Hepatitis B, Tuberculosis, Herpes, and Acquired Immunodeficiency Syndrome (AIDS).

The procedure, impression taking is the essential in dentistry, not only for constructing study models in orthodontics and prosthetics dentistry but also for fabricating either fixed and removable prosthesis or implants prosthetics dentistry. During this procedure, impression materials may come into contact with oral tissues, saliva, and/or blood and it is generally assumed that once an impression is made, oral microbes are retained on the impression surfaces and persist thereon during the succeeding period (Samaranayake & Jennings, 1991).

In 1983, Leung and Schonfeld pointed out the recovery of microorganisms from the stone cast that retrieved from contaminated impression which shows that dental casts may also be a medium of cross-contamination between patients and dental personnel.

Among various impression materials, alginate, irreversible hydrocolloid materials tend to possess a higher intrinsic retentive potential for microbes during impression making. Its potential of retention of bacteria is two to five times greater compared with that of other elastomeric impression materials. This is

because of its organic in part, and hydrophilic and porous in nature. Alginate impressions are widely used to form study casts used to plan treatment, monitor changes, and fabricate provisional restorations and removable dental prostheses (Powers, 2011).

Recommendations and guidelines advocated the use of disinfecting solution, but there is still no universally recognized disinfection protocol for all impression materials (Blair & Wassell, 1996).

The researchers emphasized the infection control protocol to fulfill the dual purpose in that the disinfectant must be an effective antimicrobial agent while the dimensional stability and surface texture features of the impression material and resultant gypsum cast are being caused no adverse response because these physical properties are necessary for a true copy of the molded anatomical structures in order to provide a well-fitting and functional finished appliance.

Three methods of cold disinfection of impression materials exist; soaking, spraying, mixing with, or a substitute for, water used to mix alginate (Ahmad *et al*., 2007). Of the various methods of disinfectant agent application, immersion is considered to be the most reliable (ADA Council on Scientific Affairs and ADA Council on Dental Practice, 1996) because spraying tends to pool and thus all impression surfaces may not be adequately covered.

Chemical disinfectants for impression materials can be broadly classified into three categories (Monlinary & Runnells, 1991), high-level disinfectants namely, ethylene oxide gas or glutaraldehyde solutions which are able to inactivate spores and all other microbial forms (Matyas *et al*., 1990), intermediate level disinfectants namely, formaldehyde, chlorine compounds (e.g., sodium hypochlorite), iodophors and quaternary ammonium compounds, which may not inactivate spores but will destroy other microbes, in particular tubercle bacilli (Matyas *et al*., 1990), and low level disinfectants namely alcohols phenolic compounds, simple phenols, detergents which are unacceptable for disinfection of contaminated impressions (Monlinary & Runnells, 1991).

Alkylbenzyldimethylammonium chloride (ADBAC) is one of the quaternary ammonium compounds which have biocidal action derived from its alkaline rings. In this study, we applied the manufacturer's recommended concentration (1%) and exposure time (3 minutes) of it as reported in infection control recommendations for the dental office and the dental laboratory, "Since the compatibility of an impression material with a disinfectant varies, manufacturers' recommendations for proper disinfection should be followed" (ADA council on scientific affairs and ADA council on dental practice, 1996).

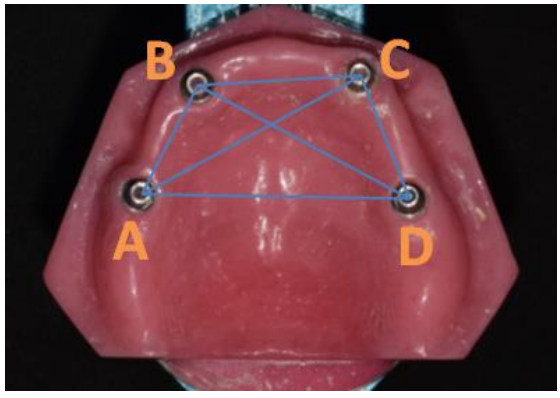
If sodium hypochlorite is used as a disinfectant, the American Dental Association (1991) recommends immersion disinfection for 10 minutes in concentration of 1:10 dilution (0.525%). Wala *et al*. (2009) and Ko-Ko (2010) also confirmed the efficacy of immersion in 0.5% sodium hypochlorite solution on oral microflora.

In this study dimensional stability of available two selected alginate products on dental stone casts are being used to analyze after disinfection by immersion in 1% alkylbenzyldimethylammonium chloride (Impresafe) for 3 minutes and 0.5% NaOCl for 10 minutes respectively.

Materials and Methods

In this *in vitro* comparative study, the

procedure for impression taking was performed by using acrylic master model of upper maxillary arch set up on plane line articulator on which four dummy implant prosthetics abutments are engaged at premolars and molar regions. The distance between premolar abutments is 25.53 mm, the distance between molar abutments is 41.85 mm and the distances between premolar and molar abutments at right side is 19.34 mm and at left side is 20.4 mm (Figure 1 and 2).



AB=19.34 mm	CD=20.4 mm
AC=39.17 mm	BD=37.33 mm
AD=41.85 mm	BC=25.53 mm

Figure 1. Master maxillary acrylic model with implant prosthetic abutments

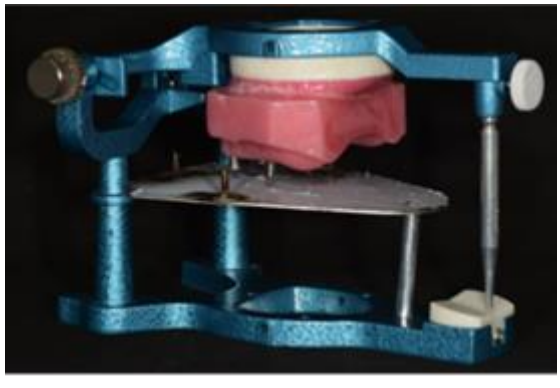


Figure 2. Master maxillary acrylic model set up on mean valued articulator

The impression of acrylic master model is made by using machined mixed alginate with correct water-powder ratio recommended by manufactures. Thirty impression samples for each of two different alginates were taken from a maxillary acrylic model and then immersed in 1% alkylbenzyldimethyl-ammonium chloride (Impresafe) for 3 minutes and 0.5% NaOCl for 10 minutes respectively.

The measurements for linear dimensional stability were carried out by digital slide caliper in six distances (2 antero-posteriors, 2 cross-arches (trans-verse) and 2 cross-arches (diagonals) on resultant dental stone casts. The measurements were analyzed by independent *t* test for comparison between groups. Level of significance was set at $p<0.05$. This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon.

Results

Linear dimensions of all tested alginate impressions had changed after immersion in both chemical disinfectants. In comparison of mean difference from master model, there were no statistically significant different between majority of study measurements on stone casts retrieved from alginate 1 and 2 impressions disinfected with two studied chemical disinfectants (Table 1 and 2).

Table 1. Comparison of mean difference from master model of study measurements on stone casts retrieved from alginate 1 impressions disinfected with two studied chemical disinfectants (n=60)

	Mean difference from master model(SD) (mm)		Mean difference (95%CI)	*t* statistic (df)	*p*-value*
	Impresafe	Sodium hypochlorite			
AB	0.07 (0.08)	0.26 (0.18)	-0.19 (-0.3, -0.1)	-3.96 (19.16)	0.001
CD	0.33 (0.13)	0.11 (0.10)	0.23 (0.14, 0.31)	5.47 (28)	0.000
AC	0.31 (0.44)	0.30 (0.20)	0.01 (-0.25, 0.27)	0.09 (19.77)	0.93
BD	0.39 (0.30)	0.31 (0.20)	0.09 (-0.11, 0.28)	0.92 (24.31)	0.37
AD	0.11 (0.13)	0.15 (0.11)	-0.04 (-0.13, 0.05)	-0.93 (28)	0.36
BC	0.16 (0.10)	0.11 (0.14)	0.05 (-0.03, 0.14)	1.24 (28)	0.23

*Independent *t* test

Table 2. Comparison of mean difference from master model of study measurements on stone casts retrieved from alginate 2 impressions disinfected with two chemical disinfectants (n=60)

	Mean difference from master model(SD) (mm)		Mean difference (95%CI)	*t* statistic (df)	*p*-value*
	Impresafe	Sodium hypochlorite			
AB	0.02 (0.03)	0.09 (0.05)	-0.02 (-0.10, -0.04)	-4.54 (28)	0.000
CD	0.10 (0.05)	0.15 (0.14)	-0.05 (-0.13, 0.03)	-1.30 (17.14)	0.21
AC	0.02 (0.15)	0.12 (0.18)	-0.10 (-0.22, 0.03)	-1.58 (28)	0.13
BD	0.20 (0.19)	0.28 (0.47)	-0.08 (-0.35, 0.19)	-0.61 (28)	0.55
AD	0.12 (0.17)	0.11 (0.09)	0.01 (-0.09, 0.12)	0.29 (20.82)	0.77
BC	0.03 (0.07)	0.003 (0.21)	0.03 (-0.09, 0.15)	0.48 (17.31)	0.64

*Independent *t* test

Table 3. Mean deviation (mm) of study distances from master model on stone casts retrieved from alginate 1 impressions disinfected by two studied disinfectants (n=60)

	AB	CD	AC	BD	AD	BC
Impresafe	0.07	0.33	0.31	0.39	0.11	0.16
Sodium hypochlorite	0.26	0.11	0.30	0.31	0.15	0.11

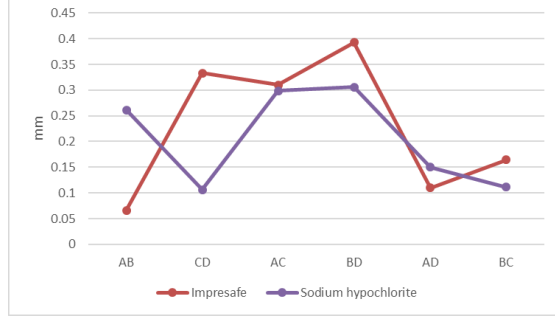


Figure 3. Mean deviation (mm) of study distances from master model on stone casts retrieved from alginate 1 impressions disinfected by two studied disinfectants (n=60)

The distance BD of casts fabricated from impressions of alginate 1 disinfected by immersion in 2% glutaraldehyde has the highest mean deviation value among the other distances (0.39 mm) (Table 3, Figure 3).

Table 4. Mean deviation (mm) of study distances from master model on stone casts retrieved from alginate 2 impressions disinfected by two studied disinfectants (n=60)

	AB	CD	AC	BD	AD	BC
Impresafe	0.02	0.10	0.02	0.2	0.12	0.03
Sodium hypochlorite	0.09	0.15	0.12	0.28	0.11	0.003

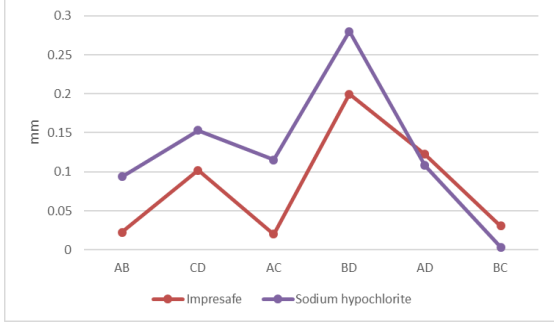


Figure 4. Mean deviation (mm) of study distances from master model on stone retrieved from alginate 2 impressions disinfected by two studied disinfectants (n=60)

The distance BC of casts fabricated from impressions of alginate 2 disinfected by immersion in 0.5% sodium hypochlorite has the lowest mean deviation value among the other distances (0.003 mm) (Table 4, Figure 4).

Discussion

In this study, compared with the acrylic master model, casts made from two different irreversible hydrocolloid impressions disinfected by immersion in two different chemical disinfectants were found to be maintained linear dimensional stability in both the anteroposterior and cross arch dimensions. Dimensional change in all specimens was found to be a change of less than 0.33 mm (mean deviation) in the anteroposterior dimension and 0.39 mm (mean deviation) in the cross arch (width) dimension when compared with the acrylic master model.

Hellie *et al*., (1985) demonstrated that posterior teeth are displaced 0.84 mm on the average with wedging and thus are capable of significant movement physiologically (Hellie *et al*., 1985). Gates and Nicholls (1981) has shown that distortion occurring after a mandibular opening greater than 20 mm ranges from 0 to 0.5 mm. Protrusive movements also cause the mandible to decrease in arch width from 0.1 to 0.5 mm (Gates & Nicholls, 1981). The distortion of casts made on disinfected impressions, is smaller than physiologic tooth movement and distortion of the mandible during mouth opening in impression procedure. This suggests that clinically, the distortion due to disinfection is negligible and irreversible hydrocolloid impressions can be safely disinfected by immersion with any of the disinfectants used in this study.

According to Taylor *et al*., (2002), the improvement in linear dimensional stability may be due to initial syneresis (causing contraction of impression material) counteracted by imbibition during disinfection and/or linear expansion of the setting gypsum material counter-acting imbibition, thus creating a more accurate cast. The results of this *in vitro* study can be considered to be an agreement of this theory.

Moreover, the least dimensional stability of specimen (0.39 mm) was observed in cast retrieved from alginate 1 (color-changed) and the most stable linear dimension of specimen (0.003 mm) was presented by cast retrieved from alginate 2 (no color-changed).

The observations of this study are

parallel with that of Buchan and Peggie, (1966). The decrease in pH was more marked with the color-changed alginate than with the others (Bhushan, 1999). Bayindir *et al.,* (2002) also stated that hydrocolloids with a high pH showed better dimensional stability than those with a low pH.

Conclusion

1% alkylbenzyldimethylammonium chloride (ADBAC) should be considered as chemical disinfectant of choice for immersion disinfection of irreversible hydrocolloid impression material like the recommended chemical disinfectant, 0.5% sodium hypochlorite.

COI

The authors declare there is no potential conflict of interest.

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Dentoskeletal Changes of Skeletal Class III Malocclusion with Severe Facial Asymmetry after Orthognathic Surgery: Case Report

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Abstract **- Craniofacial asymmetry is expressed as the difference in size between two parts of the face. It is originated by a discrepancy in size and position between the cranial base and the maxilla, between the cranial base and the mandible, or between the maxilla and the mandible. When the craniofacial asymmetry is severe and the patient has completed growth, the indicated treatment is performed in conjunction with orthodontics and orthognathic surgery, traditional approach or surgery first approach. A 24 year-old woman had chief complaints of mandibular protrusion and facial asymmetry. Extraoral examination indicated mandibular deviation to the right side, severe facial asymmetry, and a concave profile. Orthognathic surgical treatment plan was Lefort I osteotomy and two-piece maxillary osteotomy to correct the posterior crossbite. Concomitant surgical procedure for the mandible was bilateral sagittal split osteotomy to correct facial asymmetry and mandibular protrusion. After orthognathic surgery followed by postsurgical orthodontic treatment reveals skeletal Class I and acceptable facial aesthetics with Class I occlusion. According to this case report, double jaw surgical procedure including maxillary and mandibular movements is indicated for the treatment of severe facial asymmetry and skeletal Class III malocclusion.**

Keywords; facial asymmetry, mandibular protrusion, presurgical orthodontic treatment, orthognathic surgery, postsurgical orthodontic treatment

Received: October 2019
Accepted: December 2019

Introduction

Facial asymmetry may be associated with class I occlusion, but this is more frequently associated with class II and III occlusions. In some cases, the facial asymmetry is secondary to condylar hyperplasia or hypoplasia, ankylosis of the temporomandibular joint, displaced condylar fractures, or hemifacial microsomia. The etiology of facial asymmetry for many other cases is still unknown. Facial asymmetry can be outlined and divided into three main categories; congenital, developmental, arising during growth with inconspicuous etiology; and acquired, resulting from injury or disease (Cohen, 1995; Hegtvedt, 1993; Reyneke *et al*., 1997).

Facial asymmetry including mandibular deviation to the right or left side is one of the most challenging problems to correct in orthodontics. (Proffit, 1991; Pirttiniemi, 1994). Mandibular asymmetry is very common and may create the esthetic concerns and functional irregularities. In most cases, mandibular asymmetry is usually associated with an occlusal cant and cannot be treated without

double-jaw orthognathic surgery (Cheong & Lo, 2011).

Skeletal deformity requires surgical orthodontic treatment for correction. The traditional approach for these patients requires:

- Pre-surgical stage: leveling and alignment, correct dental compensations and coordinate arches,
- Surgical stage: to perform the orthognatic surgery procedures and
- Post-surgical stage: to detail occlusion.

The another new technology that is surgery first approach applied to the orthodontic systems and the new biological model allow the orthodontist to delay less time in the pre-surgical and post-surgical stages, condition appreciated by the patients, mostly because after relieving dental compensations there is a worsening of facial aesthetics and masticatory discomfort in the pre-surgical orthodontics stage (Montesinos *et al*., 2017). Orthodontic treatment is usually an integral part of contemporary orthognathic treatment. In most cases, the attainment of a satisfactory post-surgical occlusion will require the use of fixed appliances to achieve optimal arch coordination and inter-digitation (Ayoub *et al*., 2014).

Case Report

A 24 year-old woman had chief complaints of mandibular protrusion and facial asymmetry. Extraoral examination indicated mandibular deviation to the right side, severe facial asymmetry, and a concave profile, mandibular prognathism and increased lower one third of the face. The facial photographs of the patient indicated severe facial asymmetry with a mandibular deviation and a concave profile (Figure 1). Maxillary midline coincide with facial midline and mandibular midline was shift 5mm to the right from facial midline. The mandibular dental midline was deviated 5 mm toward the right side according to the maxillary dental midline, and the patient had both anterior and posterior crossbites. Intraoral examination showed Class III canine and molar relationships on the left side and Class III canine and Class I molar relationships on the right side. Reversed overjet and 1 mm overbite was seen. There was a minus two millimeters arch length discrepancy on both arches. Inclinations of the occlusal plane greater than 4° and menton deviations observed in the posteroanterior cephalograms are important characteristics to determine the presence and extension of facial asymmetry. The patient of this case presented significant facial asymmetry, mandibular asymmetry and menton deviation to the right.

Cephalometric analysis indicated Class III relationship (ANB, −5.2°), average maxillary basal bone (SNA, 81.3°) and mandibular protrusion (SNB, 88.4°), and high mandibular plane angle (FMA, 32.3°). The upper incisors were proclined (U1 to SN, 116.5°), whereas the lower incisors were retroclined (IMPA, 80.1°) (Table 1). Concave facial profiles, mandibular prognathism and increased lower one third of the face (Table 1, Table 2, Figure 2).

Figure 1. (A) Front view of pretreatment photographs showed facial asymmetry (B) Profile view of pretreatment photographs showed skeletal class III

Table 1. Comparisons of skeletal changes before treatment, before surgery and after surgery

Skeletal Parameters	Before Treatment	Before Surgery	After surgery
Palatal plane to Mandibular Plane	28.6°	27.3°	27.2°
FMA	32.3°	32°	31.1°
Y-Axis	62.1°	63°	63.4°
Nasion Perpendicular to A point	-5.4 mm	-5.8 mm	-2.4 mm
Nasion perpendicular to Pogonion	3.1 mm	-1.6 mm	-2.4 mm
SNA	81.3°	81.3°	81.5°
SNB	88.4°	85.3°	80.8°
ANB	-7.1°	-4°	0.7°
Wits	-13.8 mm	-9.5 mm	-0.3 mm
Maxillary length	76.2 mm	76.2 mm	75.6 mm
Mandibular length	125.9 mm	111.4 mm	105.5 mm

Table 2. Comparisons of dento-facial changes before treatment, before surgery and after surgery

Dento-facial Parameters	Before Treatment	Before Surgery	After surgery
Interincisal Angle	128.9°	121.4°	119.8°
Lower 1 to MP	80.1°	87.4°	88.5°
Lower 1 to NB	4.1 mm	5.8 mm	5 mm
Lower 1 to APo	7.5 mm	7.7 mm	3.6 mm
Upper 1 to SN	116.5°	116.7°	114.5°
Upper 1 to APo	3.9 mm	4.3 mm	7.1 mm
Nasiolabial Angle	100.2°	104.8°	108.4°

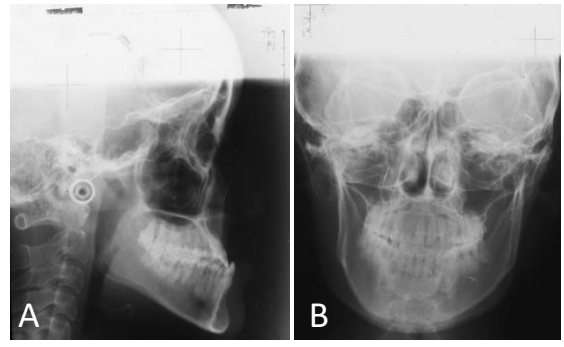

Figure 2. (A) Pretreatment lateral cephalometric radiograph showed mandibular prognathism (B) Frontal cephalometric radiograph showed skeletal asymmetry of face

Treatment Planning

The treatment objectives were as follows:
(1) to correct the skeletal discrepancy between the maxilla and mandible;
(2) to correct the skeletal and dental midlines;
(3) to achieve good facial esthetics and symmetry;
(4) to obtain Class I canine and molar relationships, including a normal overjet and overbite.

The orthognathic surgery was unavoidable because of severe skeletal mandibular asymmetry. Therefore, treatment plan was double- jaw surgery for the patient. To correct class III facial profile, advancement surgery with Lefort I osteotomy was planned. To correct the facial asymmetry and mandibular protrusion, concurrent bilateral sagittal split osteotomy was performed.

Treatment

Full fixed 0.022 inch MBT prescribed appliances were placed on the teeth in both arches. Leveling and aligning was initiated by 0.012 inch nickel-titanium archwire and continuing upto 0.016×0.022 inch stainless steel archwire placed just before surgery.

The advancement surgery with Lefort I osteotomy and two pieces maxillary osteotomy at maxillary to correct the posterior crossbite was performed together with bilateral sagittal split osteotomy to correct the facial asymmetry and mandibular protrusion.

Orthodontic treatment was started one and half months post-surgery and bonded the brackets on the some of the teeth where the brackets were popped off during and after surgery. The 0.014 inch NiTi archwire was used to align the teeth and continuing the treatment (Figure 3).

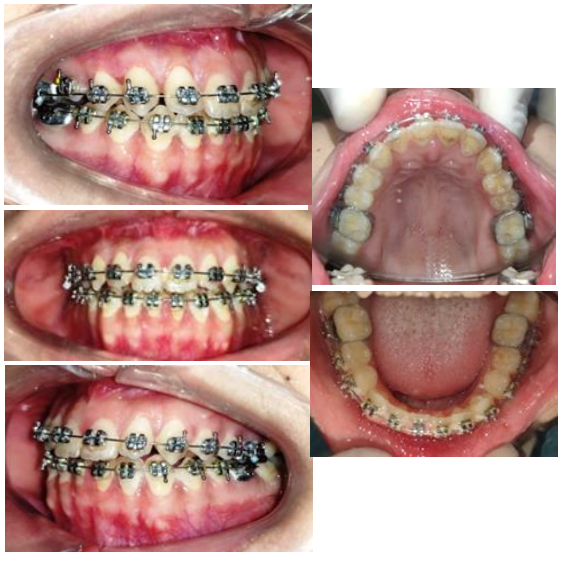

Figure 3. Intraoral photographs (One and half months after surgery) after rebonding of brackets

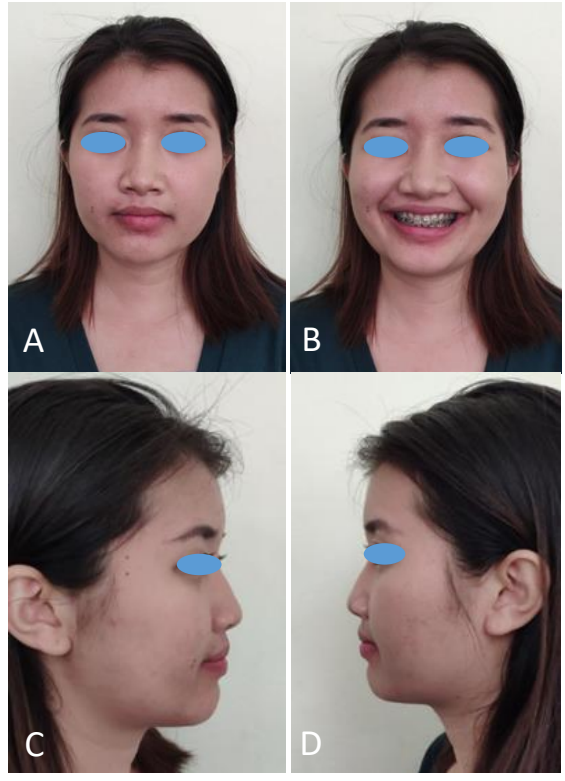

Figure 4. (A, B) Extraoral photographs of front view, (C, D) Extraoral photographs of profile view (One and half months after surgery)

Figure 5. Intraoral photographs (3 months after surgery) after space closure of residual spaces

Treatment Results

As a result of slight advancement of the maxilla, setback and transverse rotation of the mandible, facial esthetics was improved. The anterior and posterior crossbites were corrected; maxillary and mandibular midlines were made coincident with each other. The post-treatment posteroanterior cephalometric radiograph showed improvement of the mandibular symmetry. Class I canine and molar relationships were obtained (Figure 5).

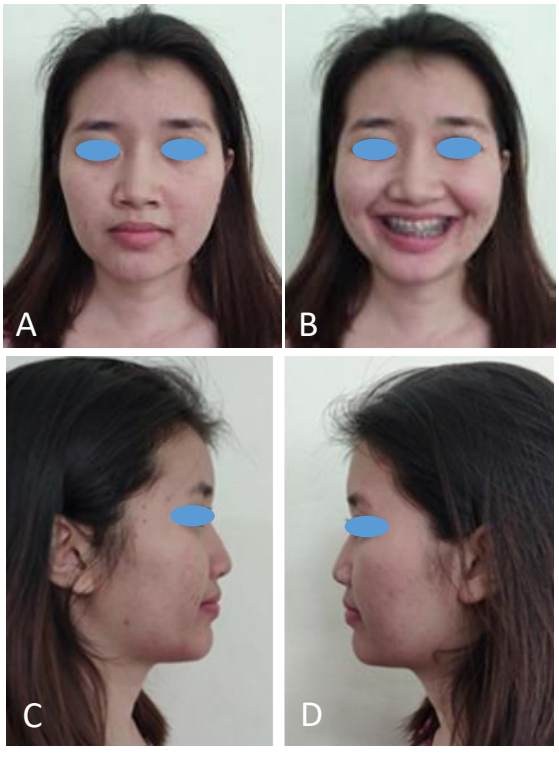

Figure 6. (A, B) Extraoral photographs from front view showed improvement of mandibular symmetry, (C, D) Extraoral photographs from profile view showed skeletal class I (3 months after surgery)

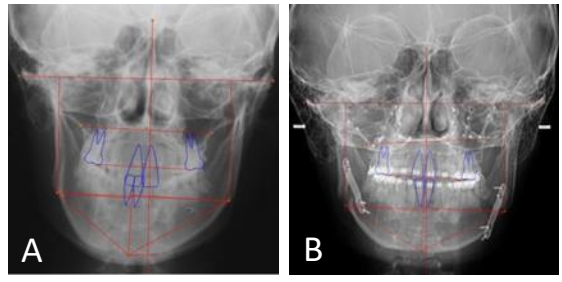

Figure 7. Frontal Cephalometric Radiographs: (A) Facial asymmetry before surgery, (B) Improvement of facial asymmetry after surgery

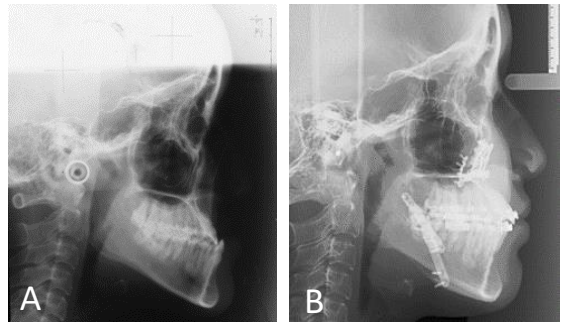

Figure 8. Lateral Cephalometric Radiographs: (A) Skeletal class III mandibular protrusion before surgery, (B) Changes of skeletal pattern after surgery

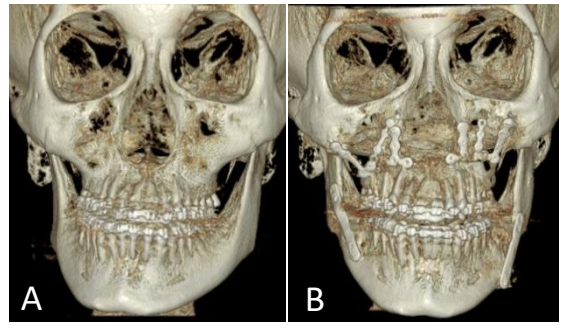

Figure 9. Changes of skeletal asymmetry seen on CBCT: (A) Before surgery, (B) Improvement of skeletal asymmetry after surgery

Discussion

The aims of the treatment in Class III malocclusion are to improve the facial esthetics and correct the malocclusion. Facial asymmetry is one of the most challenging problems in orthodontic treatment. Dental asymmetries without occlusal cant can be treated by orthodontic mechanics, including diagonal and midline elastics or using asymmetric tooth-extraction sequences (Atik *et al.*, 2016). However, severe skeletal asymmetries, especially in Class III malocclusions, usually require a series of complex surgical procedures combined with orthodontic treatment. Improvement of the facial profile in cases with severe facial asymmetry occurs with surgery to the mandible. Bilateral sagittal split osteotomy is the most common procedure to surgically correct mandibular deformity. When double-jaw surgery is planned for an asymmetric case, the positioning of the maxilla is considered more crucial than the repositioning of the mandible. Comparison of the initial and post-operative postero-anterior cephalometric tracings showed the improvement of mandibular asymmetry. Since the pretreatment cephalometric measurements indicated mandibular protrusion, the Class III malocclusion was corrected by a combination of mandibular setback and maxillary advancement.

Conclusion

Traditional approach of double-jaw surgical procedures, including maxillary and mandibular movements, was effective to correct severe facial asymmetry and skeletal Class III malocclusion both in the horizontal and vertical directions.

Acknowledgments

The authors are grateful to Dr. Lew Chee Kong and Department of Oral and Maxillofacial Surgery, University of Dental Medicine, Yangon, Myanmar for performing the orthognathic surgery.

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The authors declare there is no potential conflict of interest.

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Management of an Impacted Permanent Maxillary Left Central Incisor with Angular Root Dilaceration: Case Report

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***Abstract* - Uneruption of permanent maxillary central incisor is usually recognized by the parents during the child's mixed dentition period as central incisor is the most important unit of the facial esthetics. Dilaceration is one of the most common causes of uneruption of the permanent maxillary central incisors. This case report presents a 9 year old girl with the chief complaint of delayed eruption of the permanent maxillary left central incisor. On clinical examination, there was the outline of tooth bulging at the mucobuccal fold of the delayed permanent maxillary left central incisor. While taking radiographic examination, the permanent maxillary left central incisor was impacted with angular root dilaceration. Following surgical exposure with closed eruption technique and orthodontic traction, the permanent maxillary left central incisor was successfully aligned into the dental arch.**

Keywords; Dilaceration, Impacted maxillary central incisor, Dilacerated tooth

Received: October 2019
Accepted: December 2019

Introduction

Dilaceration is one of the most common causes of uneruption of the permanent maxillary central incisor (Becker, 2012). The term dilacerations refers to an angulation or a sharp bend or curve, in the root or crown of a formed tooth (Shafer, 1993). The aetiology of dilacerations is not fully understood, there were two prevailing explanations. Acute mechanical trauma to the primary tooth at an early age is most widely accepted aetiology, which causes dilaceration of the underlying developing permanent tooth (Walia *et al.*, 2016). An idiopathic developmental disorder is also another cause of dilacerations, especially in cases where there is no clear sign or history of traumatic injury (Andreasen *et al.*, 1971). Other possible causes are ectopic tooth germ development (Andreasen *et al*., 1971), presence of cyst, tumors, odontogenic hematoma (Dayi *et al*., 1997), certain syndrome such as hypermobility type of Ehlers-Danlos Syndrome (Yassin & Rihani, 2006) and hereditary factors (Witkop & Jaspers, 1982) etc. According to Silva *et al.*, (2012), the prevalence of root dilaceration is very rare about 1.03% with higher incidence in males (65.8%). The prevalence of maxillary central incisor dilaceration is range from 0.2% to 0.5% (Hamasha *et al.*, 2002; Silva *et al.*, 2012; Karadas & Tahan, 2015; Kuzekanani, 2019). 90.2% of root dilacerations were in apical third and presented with a mild curvature in 73.1%. Regarding the direction of the anomaly, the roots were distally directed in 95.1% of the incisors (Silva *et al.*, 2012).

Crown or root dilacerations can be asymptomatic or can react in various ways including un-eruption or impaction of effected tooth, eruption into malposition, midline shift, space occupation by adjacent teeth and prolong retention of primary

predecessor tooth. The treatment of dilacerated teeth should start early, to provide the opportunity for the non-calcified root to change direction and develop a proper spatial relationship with the already calcified formed crown (McNamara, 1998; cited in Topouzelis *et al.*, 2010). It is not a frequent case in daily dental practice and its treatment is challenging, careful treatment planning should take place with cooperation of various experts.

Case Description

A healthy 9 year-old girl presented at Department of Paediatric Dentistry, with complaint of an unerupted permanent maxillary left central incisor. Her past medical history was unremarkable. Her parents did not notice about traumatic injury to upper anterior teeth while she was young.

Clinical Examination

The patient presented with Class I Skeletal pattern, Molar Class I on left side, half unit Class II on right side and Class I incisor relationship. Intraoral examination revealed that the dentition was mixed dentition period with fully eruption of permanent maxillary incisors except unerupted maxillary left central incisor had resulted in mesial drifting of the maxillary left lateral incisor into the central incisor space. Center line shift did not occur. Unerupted maxillary left central incisor crown was palpable as labial budging high in the labial sulcus. Others mixed dentition problems such as cross bite at permanent maxillary right lateral incisor and early losses of both deciduous mandibular second molars were also observed.

Figure 1. Pretreatment study model, unerupted dilacerated maxillary left central incisor had seen as labial budging in the sulcus, mesial drifting of lateral incisor to unerupted central incisor space

Figure 2. Standard Occlusal view, unerupted dilacerated maxillary left central incisor with the root curve 24 degree to the long axis of the tooth with incomplete root development

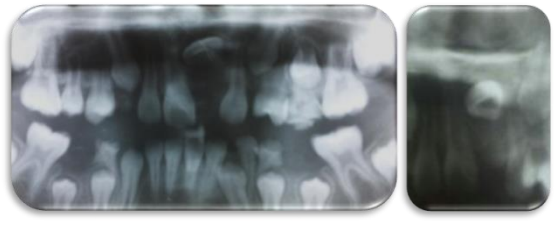

Figure 3. Pretreatment panoramic radiograph and periapical radiograph revealed impacted maxillary left central incisor with root dilacerations, which lie horizontally.

Treatment Planning

Different types of treatment options were explained to the patient and their parents. Finally, surgical exposure and orthodontic traction procedure was chosen in order to preserve her natural tooth in the oral cavity.

The following treatment plan was established.

[1] Creation of adequate space with brackets and open coil spring for impacted dilacerated permanent maxillary left central incisor prior to surgical exposure
[2] After achieving adequate space, surgical exposure and orthodontic traction with closed eruption technique for impacted dilacerated permanent maxillary left central incisor
[3] Creation of a stable functional occlusion
[4] Manage other needed malocclusion during mixed dentition period

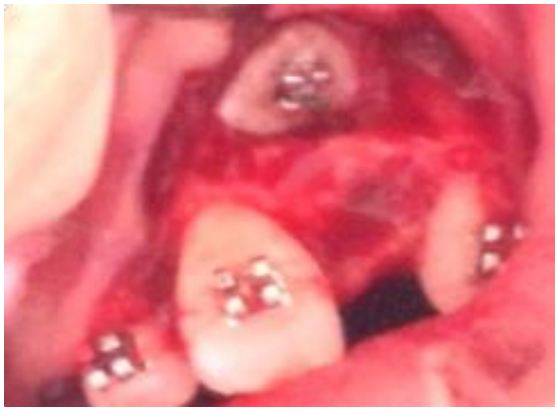

Figure 4. Surgical exposure of impacted dilacerated maxillary left central incisor and bracket was bonded on the palatal surface

Figure 5. Closed eruption technique; stainless steel ligature tie was attached to arch wire

Figure 6. Dilacerated central incisor was exposed into the oral cavity after 5 months of traction

Figure 7. Bracket was changed to the labial surface and light traction force is applied

Treatment Progress

A total of 12 months of treatment duration took an impacted dilacerated maxillary left central incisor successfully positioned into proper alignment in the dental arch (Figure 8). After treatment completion, the exposed permanent maxillary left central incisor had an acceptable gingival contour.

Radiographically, the newly positioned permanent maxillary left central incisor with dilacerated root with no apparent root resorption, ankylosis and no signs of periapical infection (Figure 9). The tooth was asymptomatic and still vital with pulp sensitivity test.

Figure 8. A total of 12 months duration took impacted dilacerated central incisor successfully positioned into normal alignment with acceptable gingival contour and still vital with pulp sensitivity test

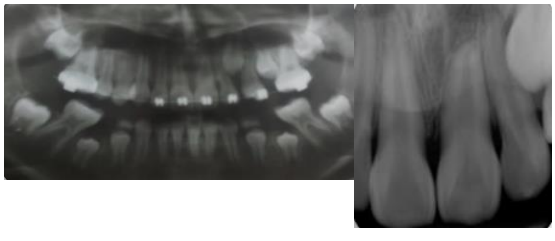

Figure 9. Post treatment panoramic and periapical radiograph revealed dilacerated permanent maxillary left central incisor with shorter root, no apparent root resorption, no ankylosis and no periapical infection

Discussion

Some treatment modalities of dilacerated tooth are (1) Extraction of dilacerated incisors followed by reimplantation (2) Surgical extraction and moving the lateral incisor to mimic the central incisor (3) Extraction followed by placement of an implant if the patient has completed growth (4) Extraction followed by prosthetic placement (5) Surgical exposure and orthodontic traction of dilacerated tooth.

Among the different types of treatment modalities, surgical exposure and light orthodontic traction for dilacerated tooth is reported as a current therapy (Topouzelis *et al.*, 2010).

Prognosis factors determining the success rate of orthodontic surgical management of the impacted dilacerated tooth are

- Degree, level and direction of dilacerations
- Tooth vertical position and
- Tooth root maturity

According to Santana, Consolaro and Tavano, (1993) cited in Silva *et al.*, (2012), the occurrence of root dilaceration, is mild (20°-40°), moderate (41°-60°), and severe (more than 61°). Prognosis is good in mild case, it decline with increasing severity of root dilacerations. In case of moderate to severe types of dilaceration, there must be checked both clinical and radiographically during orthodontics traction. There may be the need for root canal therapy and apicetomy to obtain a favorable outcome. Thus, in this kind of situation, the patient must be informed about the need for further root canal treatment and even possibility of tooth loss depending on the severity. However, in this case, the degree of root dilaceration is mild (24°), the possibility of the need for further root canal treatment and tooth loss does not exist.

The vertical position of dilacerated tooth will influence on the total treatment duration. Chushu (2015) stated that the initial height was the only variable with a significant impact on the total treatment time. The higher the dilacerated tooth is located apically; a longer period of traction will be resulted. They also reported that total treatment duration of impacted incisors due to dilaceration was more than 3 months longer than for

impactions caused by obstruction.

The direction of root dilaceration whether it curves labially or palatally significantly affected the prognosis outcome in treatment of dilacerated incisors. In labially curved root dilaceration, the incisor root apex would be palpable in the labial sulcus and root exposure can result. Becker, (1998) suggested the amputation of the root apex in such case, with subsequent obliteration of the root canal using a combined coronal and retrograde endodontic therapy.

Regarding the surgical exposure of impacted teeth, achieving proper gingival contour with good esthetic result is prime important. Window excision of the soft tissue, gingivectomy, apical reposition flap and closed eruption techniques are the commonly used methods to expose the impacted teeth. Vermette *et al.,* (1995) reported that labially impacted maxillary anterior teeth uncovered with an apical positioned flap technique have more unaesthetic sequalae than a closed eruption technique. They strongly recommended that the closed-eruption technique be the treatment of choice when the tooth is impacted in the middle of alveolus or high near the nasal spine.

Regarding this case, dilacerated central incisor with incomplete root apex, the degree of dilacerations was mild (24°), located at the middle third of adjacent tooth (7 mm distance from the alveolar crest), thus the tooth was uncovered by closed eruption technique. Above these factors are favorable for the successful management of dilacerated central incisor with proper gingival margin and the attached gingiva.

In the management of dilacer-ations, the treatment failure due to ankylosis, external root resorption, and root exposure after orthodontic traction should be taken into account. A periapical radiograph revealed a dilacerated root in apical third curved distally which compared with the adjacent incisor but no pathological signs in the periapical area were observed (Figure 9). Light traction force was used to extrude impacted dilacerated incisor in this case. This may be accounted for the maintenance of vitality of the dilacerated tooth after post-alignment.

Conclusion

As there is no better alternative to natural tooth in case of esthetic and function, possible effort should be made to align the impacted dilacerated tooth into proper position. The problem of unerupted dilacerated maxillary central incisor should be managed as early as possible because this can adversely effect on the child's social interaction. In this case, following surgical exposure with close eruption technique and orthodontic traction was relatively free from treatment-related complications and successfully has acceptable alignment into the dental arch.

Recommendations

- To monitor the development of normal occlusion and problems encounter during mixed dentition period are crucial role for Paediatric Dentist as well as General Practitioner
- To check out the impacted dilacerated tooth using Cone Bean Computed Tomography (CBCT) images, as it can overcome the problems and limited information obtained from a conventional 2 D radiograph film and can give detailed information about the impacted tooth

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The authors declare there is no potential conflict of interest.

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Practicable Alternative for Mandibular Fracture Management: Case Report

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***Abstract* - Although Open Reduction and Internal Fixation (ORIF) by using plates and screws system is gold standard for mandibular fracture management worldwide, there are some barriers to be practiced in every secondary level hospitals of Myanmar. Closed reduction by Maxillo-mandibular fixation (MMF) is still the most commonly used treatment option for mandibular fracture management. MMF by using Intermaxillary Fixation (IMF) screws is a new technique which has become popular in recent decades. It is a bone anchored technique which is completely different from other conventional MMF achieving techniques. A 25 year-old woman, worked as a teacher, from Phyuu Township, Bago Region came to Dapartment of Oral and Maxillofacial Surgery, University of Dental Medicine, Yangon for the treatment of mandibular fracture due to motorcycle accident. She was treated by using IMF screws. In this article, treatment outcomes of this case were reported.**

Keywords; fracture mandible, intermaxillary fixation screws, maxillomandibular fixation

Received: September 2019
Accepted: December 2019

Introduction

Myanmar is one of the developing countries where use of motorcycles and other vehicles in peri-urban and rural areas is increasing in recent years. According to Ministry of Health and Sports' data in Hospital Statistics Report 2014-2016, incidence of road traffic accident (RTA)-related mandibular fractures showed increasing pattern.

Open Reduction and Internal Fixation (ORIF) is globally accepted as gold standard in the overall management of mandibular fractures since Champy *et al*., (1978) proved the ideal lines of osteosynthesis. Its advantages include shorter operation time, easier to assess traumatized area, easier to reduce in comminuted fracture, and increased compliance and comfort of patients. But some drawbacks such as incidence of infection, expensive treatment costs, technically difficult, dependence of surgeon's skill and needs to do under general anesthesia are still present as controversial issues (Fonseca, 2013).

In recent decades, many developments have been made for plates and screws systems for better fixation and stabilization of the fractured segments (Luhr, 1985). Because of its expensive treatment costs compared to other treatment options, it has limitations to practice in every State and Region Hospitals of Myanmar.

Closed reduction by Maxillomandibular fixation (MMF), is still the most commonly used treatment option in Myanmar for mandibular fracture management. For achieving MMF, Erich arch bar is the most commonly used worldwide. But its usage is minimal in Myanmar because of difficult technique compared to Interdental Intemaxillary

Fixation (IDIMF) i.e. using 0.4mm diameter stainless steel wires.

These MMF methods are tooth–anchored techniques which use the strength of teeth to stabilize maxilla and fractured mandible to get correct occlusion. Advantages of this technique are low cost and can be done only with Local anesthesia. Disadvantages includes long period of immobilization, lack of patient compliance, inability to perform oral hygiene care, wire trauma to soft tissues, wire loosening and inability to obtain complete rigidity during treatment period. Moreover, it has an inherent risk of perforation of the operators' gloves and consequent wire stick injury caused by the sharp-ended wires (Coburn *et al*., 2002).

And this technique is difficult to use when teeth are grossly carious, periodontally compromised, crowded and when patients have extensive crown and bridgework. Finally, wires tightened during the application of interdental wires around the teeth may cause an ischemic necrosis of the marginal gingiva and subsequent loss of vitality of the tooth. It is also difficult to maintain gingival health (Ayoub & Rowson, 2003).

Arthur and Berardo (1989) first published an article in British Journal of Oral and Maxillofacial Surgery named "A Simplified technique of maxillomandibular fixation" introducing the use of conventional 2.0 mm titanium bone screws which are directly linked with wire loops to establish MMF. They named these bone screws as Intermaxillary Fixation (IMF) screws. MMF using IMF screws is different from other traditional MMF achieving methods. It is bone anchored method.

Several reports for numerous and distinctive advantages of IMF screws over traditional methods had been made during the 1990s (Vartanian & Alvi, 2000). Some of the advantages includes simplicity of technical handling, low risk of inadvertent skin punctures with decreased risk of transmission of viral pathogens, can be done only under local anesthesia, minimal amount of hardware in the oral cavity, improved comfort for patients and painless and fast removal in the office (Cornelius & Ehrenfeld, 2010).

The overall positive response to bone anchoring MMF technique using IMF screws fostered the design and manufacturing of specially designed IMF screws (Jones, 1999). The second-generation IMF screws has polished and smoothed capstan-style heads with milled channels for the uptake of the wires to minimize damage to the labial mucosa and increase the patient's comfort (Schneider *et al.*, 2000. During last decade, IMF screws become self-drilling which are hand inserted without predrilling and power equipment (Coletti *et al*., 2007). This provides additional safety against contamination by infectious aerosols and blood or saliva splashes generated during drilling with handpieces and avoids thermal necrosis of the bone or the mucosa (Pigadas *et al*., 2008).

Figure 1. Second-generation self–drilling Titanium IMF screw (10 mm)

Case Report

A 25 year-old woman from Phyuu Township, Bago Region came to University of Dental Medicine, Yangon with the complaint of pain at lower right posterior region for 4 days. Via through history taking, she is primary school teacher and suffered a motorcycle accident on her way back to home from school last 4 days ago. There is no initial loss of consciousness after accident and had sent to Phyuu Township Civil Hospital. At hospital, cleansing and dressing were done for lacerations and abrasions from face, leg and arm areas and no admission for hospital had been made.

On the day after injury, patient decided to go to outside private Dental clinic due to severe sharp shooting pain from right side of lower jaw. Dental Surgeon noticed there is fractured mandible via clinical examination and urged patient to look for treatment at University of Dental Medicine, Yangon.

On examination, there were two sites of fractures in the mandible: right angle area and left parasymphysis area. It was confirmed by panoramic radiograph. There was no comminution or severe displacement.

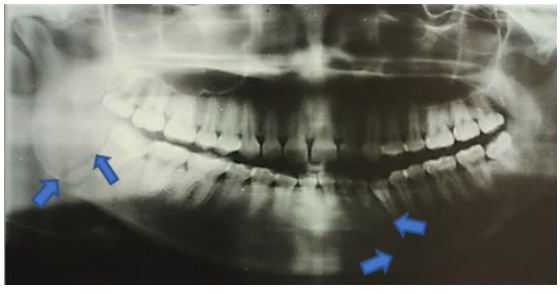

Figure 2. Pre-operative Panoramic Radiograph showing fractures present at right angle and left parasymphysis area

Screw insertion site was determined after identifying all anatomic landmarks both clinically and radiographically. Particular attention was paid to the mental and infraorbital nerve and the tooth roots, most importantly the canine root which is the longest of the tooth roots. Screws are inserted superior, and lateral to the canine root in the maxilla and inferior and lateral to the canine root in the mandible. Root tip of canine is usually located parallel to the cups tip of canine and 3 times of distance between cusp tip of the crown and cemento-enamel junction (Purmal *et al*., 2013). It is checked clinically and confirmed by preoperative panoramic radiograph.

One IMF screw was placed at junction of attached and reflected mucosa, i.e. mucogingival junction between permanent canine and first premolar of each quadrant, total of four screws (AO Surgery Reference, 2019). MMF was achieved by 0.4 mm diameter stainless steel wire by passing through the milled channels, present at capstan-style heads of IMF screws of same quadrant, i.e. total of two intermaxillary wires were used.

Operation time was only 26 minutes which was relatively short while compared to other conventional MMF techniques. And technique was easy and patient was satisfied with the treatment procedure.

Figure 3. Immediate Post-operative Photo after MMF

Patient was advised to take liquid diet only for 5 weeks and not to do any contact

sports for 6 weeks. Postoperative radiological assessment was made to access screw location and potential injury to adjacent tooth roots. Maxillomandibular fixation period was for 5 weeks and two intermaxillary wires were released after clinical assessment was made when sufficient union between two fracture segments have been achieved.

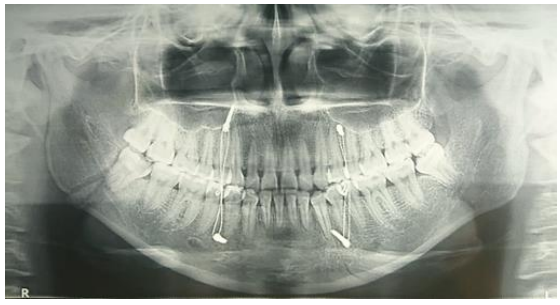

Figure 4. Post-operative Panoramic Radiograph

Four IMF screws was removed 1 week after intermaxillary wires were released. During the removal of IMF screws, it took only 12 minutes to remove all 4 IMF screws and only mild discomfort was present. Overall patients' convenience level on treatment is significantly high and as treatment outcome, acceptable pre-injured occlusion can be restored.

IMF screws need shorter operation time to insert and remove, lesser incidence of glove perforation and higher patients' convenience level. Moreover, stable occlusion can also be achieved after MMF using IMF screws. Most common limitations of IMF screws are mucosal overgrowth around screw insertion site and iatrogenic tooth root contact which can be avoided by making systematic and through preoperative clinical and radiological assessments (Cornelius & Ehrenfeld, 2010).

As conclusion, because of its usefulness outweighs limitations, use of IMF screws for achieving MMF is a practicable alternative in mandibular fracture management.

COI

The authors declare there is no potential conflict of interest.

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Osteomyelitis of Maxilla involving Multiple Cranial Bones

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***Abstract* - Osteomyelitis of the jaws is rare in today era due to the advance of antimicrobial agents and osteomyelitis of the maxilla is even extremely rare. Osteomyelitis of the jaws is associated with a complex microbiota. The two prominent causes are odontogenic infection and sinusitis. Osteomyelitis is an acute or chronic inflammatory process that can involve cortical and trabecular aspects of bone or bone marrow. Cranial bones are infrequently involved, but spreading of inflammation with involvement of surrounding structures represent the important risks, as are cerebral abscess, encephalitis, or meningitis. This study presents a case of osteomyelitis of maxilla involving multiple cranial bones caused by spreading of contiguous inflammation sustained by *Acineto-bacter baumannii*. The resolution of infection was gained with a combination of surgical treatment and antibiotic therapy.**

Keywords; osteomyelitis, maxilla, cranial bones, Acinetobacter baumannii

Received: October 2019
Accepted: December 2019

Introduction

Osteomyelitis can be defined as an inflammatory condition of the bone, which begins as an infection of the medullary cavity, rapidly involves the haversian systems, and extends to involve the periosteum of the affected area. Conditions altering the vascularity of the bone such as radiation, malignancy, osteoporosis, osteopetrosis, and Paget's disease pre-dispose to osteomyelitis. Systemic diseases like diabetes, anemia and malnutrition that cause concomitant alteration in host defenses profoundly influence the course of osteomyelitis. Necrosis of maxilla can be caused by fungal infection, trauma, irradiation, Herpes zoster, necrotizing sialometaplasia, midline lethal granuloma, Gaucher's disease, bisphosphonate related osteonecrosis of jaw (BRONJ), and bacterial infection.

In tooth-bearing bone, osteomyelitis is usually caused by polymicrobial odontogenic bacteria. Oral microflora which are most frequently involved in osteomyelitis are gram negative anaerobic rods and facultative anaerobic cocci of staphylococcus and enterococcus (Poonia *et al*., 2016). Specific infectious agents responsible for chronic osteomyelitis are difficult to identify. Nearly 80-90 % of chronic cases demonstrated *Staphylo-coccus aureus* and *Staphylococcus epidermidis*. Fungal organisms such as *Candida parapsilosis* and *Aspergillus* also have been reported causing craniofacial osteo-myelitis, especially in patients who are immuno-compromised (Elangovan & Srinivasa, 2013).

Acinetobacter baumannii is a gram-negative coccobacillus that is the etiological agent of nosocomial infections resulting in septicaemia, meningitis, endocarditis, pneumonia, and wound and urinary tract infection. It has also been identified as an ESKAPE pathogen (*Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acineto-*

bacter baumannii, Pseudomonas aeruginosa, and Enterobacter species). Other symptoms are fever and chill, rash, confusion or altered mental state and muscle pain. A total of four strains had different isolation site (Zurawski *et al*., 2012). In 101 patients with osteomyelitis of jaw, the most frequently isolated agents were *Enterobacter species, Acinetobacter baumannii,* and *Pseudomonas aeruginosa* representing about 70% of all the isolates (Cordeiro *et al*., 2012).

Dealing with osteomyelitis in head and neck bones is not the same as in other bones of the body due to the nature of the bones, complex anatomy of the region, and aesthetics. The general lack of awareness of the prevalence of the disease and its features often leads to a misdiagnosis and delay in treatment. Early detection of this condition and prompt attention will prevent the need for a surgical intervention in an otherwise protracted course of illness.

Table 1. Jaw osteomyelitis classification (Lew & Waldvoger, 1997)

Suppurative osteomyelitis	Non-suppurative osteomyelitis
Suppurative acute osteomyelitis	Chronic osteomyelitis
Primary suppurative chronic	Diffuse sclerosing osteomyelitis
Osteomyelitis secondary preceding phase	Focal sclerosing osteomyelitis
Infant osteomyelitis	Proliferative periostitis
	Osteoradionecrosis

Case Report

A 50 year-old male with history of pain at the right upper molars and premolars region last 2 years ago.

Patient had undergone dental treatment at that region and after 1 week later, he was hospitalized at 1000-bedded Nay Pyi Taw Hospital for facial edema at the right side and high fever. And transferred to Yangon General Hospital for extremely high fever, neurological complication of 6^{th} and 8^{th} cranial nerve palsy and hearing loss at the right side. Six months after the onset, hearing loss also presented at the left side. The audiogram revealed right total sensorineural hearing loss and left partial sensorineural hearing loss. Halitosis and purulent discharge in the oral cavity were noticed. There was no relief from medication, the swelling persisted and he was referred to Eyes, Nose, Throat (ENT) hospital. It was diagnosed as basal meningitis with periodontal abscess due to pansinusitis and right parapharyngeal abscess according to MRI result. There was no evidence of pulmonary tuberculosis and no evidence of *Mycobacterium tuberculosis* on marrow biopsy. One year after the onset, punch biopsy was performed to exclude the paranasal sinus (PNS) tumor, but only negative biopsy for malignancy.

On general examination patient was moderately built, poorly nourished and anemic. The patient also presented marked deterioration of his general state of health and poor oral hygiene. On extraoral examination, there is slight swelling at the right side of cheek (Figure 1). Patient had no medical history of hypertension or diabetes mellitus. There was also total hearing loss on both sides. On examination of oral cavity, multiple missing teeth in the left and right upper posterior regions were noted. But, there was no history of tooth extraction at these regions and exfoliated gradually. A large area of brownish-discolored, loose, exposed necrotic bones (sequestrums) at both sides of right and left upper posterior region was found (Figure 2). There was tenderness on palpation of gingiva along the region of sequestrum.

Upper anterior teeth showed grade III mobility. Other intraoral findings included multiple carious teeth and chronic generalized periodontitis.

Patient was treated with oral co-amoxiclav 625 mg three times per day and metronidazole 200 mg three times per day for 2 weeks and followed by oral doxycycline 100 mg twice a day and dazolic 500 mg twice a day for further 4 weeks.

Figure 1. Preoperative photo showed facial swelling at the right side of cheek

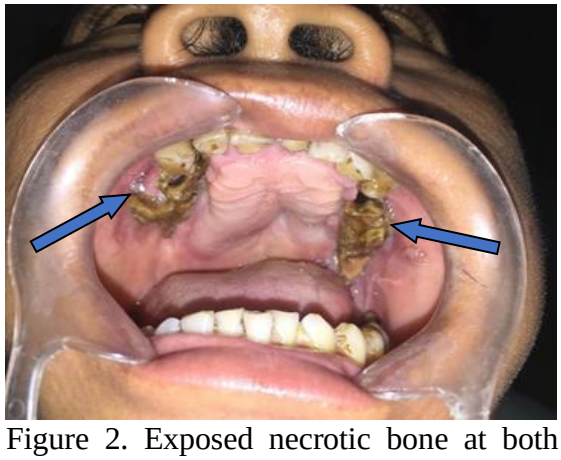

Figure 2. Exposed necrotic bone at both sides of maxillary posterior region

Investigations

The routine hematological investigation was normal except for leukocytosis and elevated ESR. Patient was seronegative for HIV and hepatitis. There was no history of steroid therapy. Panoramic radiograph demonstrated diffuse radiolucency extending from periapical region involving the palate. The patient was advised to get a computed tomography (CT) scan to know the nature and extent of the disease. CT scan showed chronic osteomyelitic changes of maxilla, floor of the temporal fossa and base of the skull. Bilateral maxillary sinusitis and left mastoiditis were also noted. Thickened and sclerosed left maxillary sinus lateral wall and left malar prominence indicate chronic osteomyelitic changes (Figure 3).

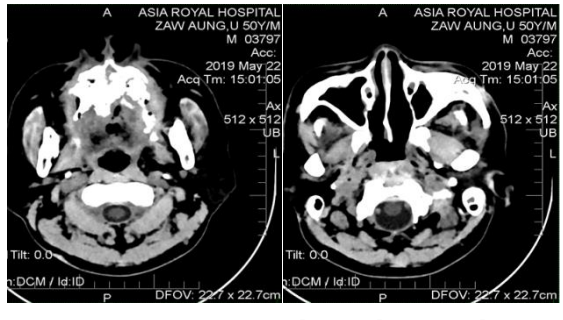

Figure 3. CT scan showed (A) chronic osteomyelitic changes of maxilla, floor of the temporal fossa and base of the skull. Bilateral maxillary sinusitis and left mastoiditis were also noted. (B) Thickened and sclerosed left maxillary sinus lateral wall and left malar prominence

Treatment

After the patient's infection was controlled, sequestrectomy and maxillectomy was planned under general anesthesia.

Crevicular incision was given on both buccal and palatal aspects. The flap was reflected. As operative finding, the whole maxilla detached from palatal bone as a

sequestrum. Fibrous tissue and small amount of bone covered the palatal bone (Figure 4). Sequestrectomy and curettage was performed along with total extraction of maxillary teeth and Type II subtotal maxillectomy (According to Cordeiro's maxillectomy classification) (Figure 5). Patient was kept under the antibiotic coverage. Specimen sent for histo-pathological examination and culture and sensitivity test. Report confirmed the lesion to be chronic osteomyelitis of maxillae which is a rare condition. Culture report showed *Acinetobacter baumannii* complex which causes osteomyelitis. According to antimicrobial sensitivity test, Tazobactam, Ceftriaxone, Sulbactam, Cefepime, Imipenem, Gentamycin, levofloxacin, Minocycline, Tigecycline and Colistin are sensitive. Postoperative period is uneventful (Figure 6). The patient was recalled after one month and showed improvement with resolution of the lesion. Prosthetic rehabilitation with removable maxillary denture was fabricated in Department of Prosthodontics (Figure 7).

Table 2. Cordeiro's maxillectomy classification (Cordeiro, 2012)

Type	To be resected
Type I. partial	1 – 2 maxillary walls
Type II. Subtotal	3 – 5 maxillary walls including palate
Type III. Total	All 6 maxillary walls a) Lacking orbital exenteration
Type IV. Radical	b) With orbital exenteration 5 maxillary walls, palate and orbit excepted

Figure 4. Intraoperative finding as the whole maxilla necrotized

Figure 5. Excised Necrotic Maxilla at both sides of maxillary posterior region (A) Left side (B) Right side

Figure 6. Postoperative healing

Figure 7. Upper removable prosthesis rehabilitation (Courtesy of Department of Prosthodontics)

Discussion

Osteomyelitis was a common disease before the advent of antibiotics. Osteomyelitis, once a dreaded condition, has lost its ability to instill fear predominantly due to advances in current resources for accurate diagnosis, surgical treatment, and potent antibiotic therapy resulting in better outcomes (Habib *et al*., 2016). The incidence of maxillary osteomyelitis is low as the bone has thin cortical plates associated with high degree of vascularity. Cranial bones are infrequently involved, but infection spread to surrounding structures can lead to cerebral abscess, encephalitis, or meningitis (Sasindran *et al*., 2015).

Osteomyelitis of maxilla was originally described by Rees in 1847. There has been another case reported with osteomyelitis of maxilla that led to meningitis by direct extension (Elangovan & Srinivasa, 2013). Osteomyelitis of the maxilla is more frequently seen in younger patients, infants, and at the age range of 40-60 years. Lesions are normally quite extended, often with undistinguished borders. The most common presenting signs and symptoms of maxillary osteomyelitis include fever, headache, facial pain and swelling, mucosal ulceration and necrosis. Progressive bony destruction and formation of sequestrations are hallmarks of osteomyelitis (Sharma *et al*., 2014).

Maxillary osteomyelitis can be classified based on the following causes; traumatic, rhinogenic, and odontogenic. Lew and Waldvoger (1997) classified osteomyelitis of the jaw into suppurative and non-suppurative, depending on its infectious character or hematogenous origin (Table 1).

Radiographically spotty osteolytic changes are more frequently observed in chronic osteomyelitis of the maxilla. Cross sectional imaging modalities such as computed tomography (CT) scanning and magnetic resonance imaging (MRI) are now considered standard for diagnosing osteomyelitis. That assists the surgeon to plan optimal surgical management, avoiding morbidity and complications to adjacent critical structures. CT is superior to MRI in detecting sequestrum, cloaca, involucre (Narsapur *et al*., 2016).

Skull base osteomyelitis represents a life-threatening complication of external ear canal infection. Malignant otitis externa usually begins as an external auditory canal infection followed by osteomyelitis of the temporal bone. Typically, skull base osteomyelitis infection begins in the external ear canal, but spread of infection from paranasal sinuses has also been occurred. Manifestations are severe otalgia, discharge, and cranial nerve palsy (VI, VII, VIII, IX, X, XI, XII). Currently, a cultured-based antibiotic therapy remains the main treatment option in skull base and temporal bone osteomyelitis (Fish *et al*., 2012). In this case, the patient also suffered complications of external ear infection and lost his sensorineural hearing loss and cranial nerve palsy, followed by osteomyelitis of floor of temporal fossa.

Systemic diseases like diabetes, anemia, and malnutrition that cause concomitant alteration in host defenses profoundly influence the course of osteomyelitis. Some studies have found that up to 68% of cases, associated with hyperglycemia secondary to uncontrolled diabetes (Gill & Pulcini, 2019). But, this patient did not have any previously known risk factors, including diabetes, malignancy irradiation, chemotherapy, autoimmune disease, steroid use, hepatitis or HIV infection.

Acinetobacter baumannii is an opportunistic pathogen that has become increasingly important over recent years as

a cause of nosocomial infections. *Acinetobacter baumannii* is associated with invasive infections, including osteomyelitis. It had a high degree of antimicrobial resistance, particularly to carbapenems. Few therapeutic options are available for treating pan-resistant strains, colistin and tigecycline has been used, but resistance to these options frequently emerges in clinical practice. In this case, patient was prescribed with co-amoxiclav and followed by doxycycline and this was already same according to sensitivity test.

Osteomyelitis of maxilla is difficult to treat because of anatomic and esthetics considerations. The goal of the treatment is eradication of the infection and restoration of the function. The treatments for the maxillary osteomyelitis range from a noninvasive approach to a more invasive radical treatment. The main treatment consists of stabilizing the systemic conditions of immuno-compromised patient, culture of the associated microorganism, sensitivity tests, image assessment to determine the lesion extension, empiric administration of the antimicrobial drugs to combat predominant microorganism, removal of septic foci such as teeth and bone sequestrations, debridement, decortications or resection according to the case (Burduk *et al*., 2010).

A combination of antibiotic treatment with surgery has shown to be effective in treating the condition. Wide spectrum antibiotic should be given initially as osteomyelitis usually present in association with an ulcer and soft tissue infection. Finally, proper antibiotic should be administered based on microbial examination of bone cultures (Nanwani *et al*., 2019). Surgical treatment involves removal of loose teeth and sequestrum, debridement, decortication, resection and reconstruction. Saucerization implies freeing of the upper cortical section to expose medullary cavity and debride necrotic tissues. Decortication implies removal of infected bone cortex. Resection is useful for low degree or refractory stages according to Cordeiro's classification (Table 2). Resection options for non-viable or infected bone of the maxilla can range from a simple excision to a radical maxillectomy (Pattnaik *et al*., 2017). The relapse rate can be as high as 20 %. The resultant maxillary defect can be managed with either prosthetic rehabilitation alone or reconstruction with subsequent dental or facial prosthesis (Sasindran *et al*., 2015).

Oxygen content of the tissue is crucial in the recovery from osteomyelitis. In addition to conventional methods such as intensive antibiotic therapy, surgical curettage, and drainage and removal of cause, hyperbaric oxygen (HBO) can beneficially influence the courses of persistent sinuses in chronic osteomyelitis. It is an adjunct in osteomyelitis therapy since it can elicit tissue hyper-oxygenation effect, antimicrobial activity, fibroblastic proliferation, neovascularization and bone matrix (Lentrodt *et al*., 2007).

Conclusion

Infection of the maxilla can cause serious complications for the patient such as infection of the cranial cavity and brain. Thus, it is essential that any maxillary osteomyelitis should be treated aggressively by the surgeon to avoid subsequent dreaded consequences. Timely treatment of this disease is paramount. Secondary osteomyelitis of the jaw due to odontogenic infections is now decreasing in prevalence due to the broad-spectrum antibiotic coverage during dental procedures. Despite this, it still remains a challenging clinical entity in developing countries.

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The authors declare there is no potential conflict of interest.

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